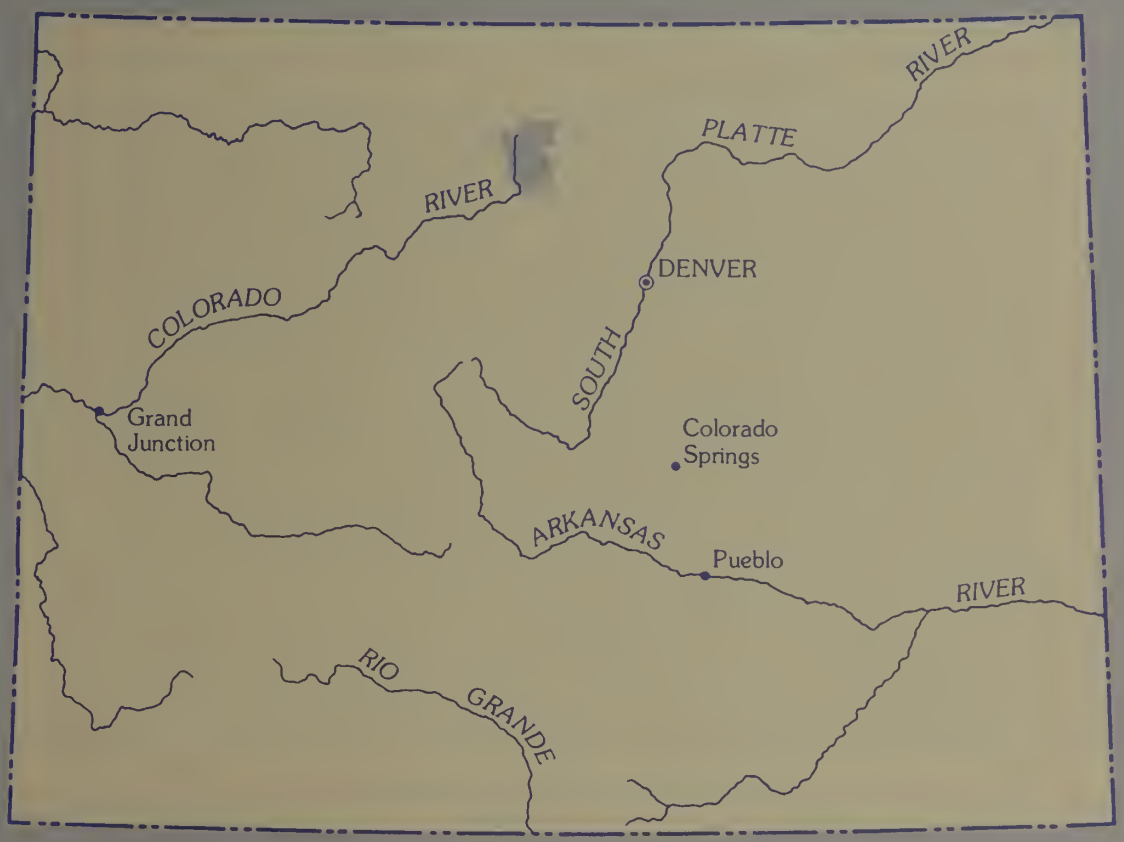
SEASONAL CHANGES IN PHYTOPLANKTON POPULATIONS AND RELATED CHEMICAL AND PHYSICAL CHARACTERISTICS IN LAKES IN LOCH VALE, ROCKY MOUNTAIN NATIONAL PARK, COLORADO

U.S. GEOLOGICAL SURVEY



Water-Resources Investigations Report 86-4101

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By Diane McKnight, Mark Brenner, Richard Smith, and Jill Baron

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Water-Resources Investigations Report 86-4101

Denver, Colorado
1986

DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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CONVERSION FACTORS

For use of readers who prefer to use inch-pound units, conversion factors for terms used in this report are listed below:

Multiply	*By*	*To obtain*
meter (m)	3.281	foot
kilometer (km)	0.6214	mile
hectare (ha)	2.471	acre
liter (L)	0.2642	gallon
cubic meter per second (m^3/s)	35.31	cubic foot per second
nanometer (nm)	3.281×10^{-9}	foot
milligram (mg)	0.03527×10^{-3}	ounce, avoirdupois
milliliter (mL)	0.03382	ounce, fluid
centimeter (cm)	3.281×10^{-2}	foot
cubic meter (m^3)	35.32	cubic foot

Temperature in degree Celsius (°C) can be converted to degree Fahrenheit (°F) as follows:

$$°F=9/5\ °C+32$$

The following terms and abbreviations are also used in this report:

micrograms per liter (µg/L)
micromolar (µ*M*)
milligrams per liter (mg/L)
(relative) *in vivo* fluorescence (IVF) units

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ABSTRACT

Phytoplankton populations and related chemical and physical characteristics were monitored in Sky Pond and The Loch in Loch Vale, Rocky Mountain National Park, Colorado, during the spring, summer, and fall of 1984, as part of a long-term study to determine the effects of precipitation chemistry on biogeochemical processes in high-elevation lakes and drainage basins that might be adversely affected by acid rain. Three distinct periods in the sequence of phytoplankton populations were observed: (1) A spring population peak that was dominated by diatoms, mainly *Asterionella formosa*, and some green algal species; (2) a midsummer population minimum, when the diatom populations decreased 10- to 100-fold; and (3) a fall population peak, which was almost unialgal, dominated by a filamentous blue-green alga, *Oscillatoria limnetica*. The spring diatom peak could have been caused by the two-fold increase in nitrate concentration during the spring snowmelt. The midsummer diatom decrease most likely was caused by zooplankton grazing, or photoinhibition, or both, rather than by phosphate depletion because orthophosphate concentrations increased at this time. It is further hypothesized that the rapid flushing rates during spring are an important factor regulating phytoplankton populations in these lakes.

INTRODUCTION

A study of phytoplankton populations and related chemical and physical characteristics in Sky Pond, Glass Lake, and The Loch in Loch Vale in Rocky Mountain National Park, Colorado, was begun in the spring of 1984. The purpose of this study was to describe the seasonal changes in phytoplankton abundance and species composition in relation to seasonal changes in nutrient concentrations [nitrate (NO_3), ammonia (NH_4), and phosphate (PO_4)] and in the physical characteristics of the lakes (flushing rate, light intensity, ice cover, and temperature, for example). This information will be used to compare the lakes in Loch Vale with other alpine and montane (subalpine) lakes where the phytoplankton has been studied and to design future onsite experiments to determine the response of the phytoplankton to potential increasing nitrate concentrations that could result from acid rain.

Purpose and Scope

This report presents the phytoplankton data collected at Sky Pond, Glass Lake, and The Loch from May 1984 through January 1985. Phytoplankton data for Sky Pond were collected on 11 days from May 29, 1984, to January 22, 1985. Phytoplankton data for Glass Lake only were collected on May 22, 1984. Phytoplankton data for the Loch were collected on 14 days from May 23, 1984, to January 22, 1985. Other data collected at Sky Pond and The Loch include concentrations of major cations and anions, nutrients, organic carbon, and chlorophyll. Some preliminary interpretations are made pertaining to the causes of the phytoplankton population peaks in the spring and fall of 1984 and of the substantial phytoplankton population decrease in midsummer.

Location and Description of the Study Area

The study area is the Loch Vale area in Rocky Mountain National Park, Colorado, which contains three lakes: Sky Pond, Glass Lake, and The Loch, which are drained by a perennial stream, Icy Brook (fig. 1). These lakes are all oligotrophic and dilute; the lakes occupy cirques formed during former advances and retreats of Taylor Glacier. Sky Pond (fig. 2) is classified as an alpine lake based on its elevation of 3,322 m; it is typical of other alpine lakes in Colorado with a rock-and-gravel drainage basin and year-round snowfields in the drainage basin (Pennak, 1963). Sky Pond has surface area of about 3.03 ha, a maximum depth of 7.3 m, an average depth of 4.5 m; the lake does not become thermally stratified during spring and summer. Glass Lake (fig. 3) has an elevation of 3,292 m; it is at treeline, surrounded by krummholtz, rocks, and meadows. Glass Lake has a surface area of 1.01 ha, a maximum depth of 4.7 m, and an average depth of 2.8 m. The Loch (fig. 4) has an elevation of 3,048 m; it is surrounded by a spruce-fir forest composed of Engleman spruce, subalpine fir, and a few limber pines. The Loch has a surface area of about 4.98 ha, and is shallower than Sky Pond, with a maximum depth of 4.7 m at a depression in the southeast part of the lake bed and an average depth of 1.5 m. Both Glass Lake and The Loch are classified as montane (or subalpine) lakes and do not become thermally stratified during spring and summer. These lakes are visited frequently by hikers and campers during the summer. The lowest lake in elevation, The Loch, is 2 km from the nearest parking lot road. The morphometric characteristics of the three lakes is summarized in table 1.

Acknowledgments

This study was conducted as part of the Acid Rain Program of the U.S. Geological Survey, with the collaboration and support of the National Park Service, Water Resources Laboratory, Rocky Mountain National Park, and the Natural Resources Ecology Laboratory of Colorado State University. We acknowledge the field assistance provided by Steven Zary, Brian Olver, Sarah Spaulding, and David Beeson of the National Park Service. Further, we acknowledge Steven Canton and James Chadwick (Chadwick and Associates) for identification and enumeration of algal species.

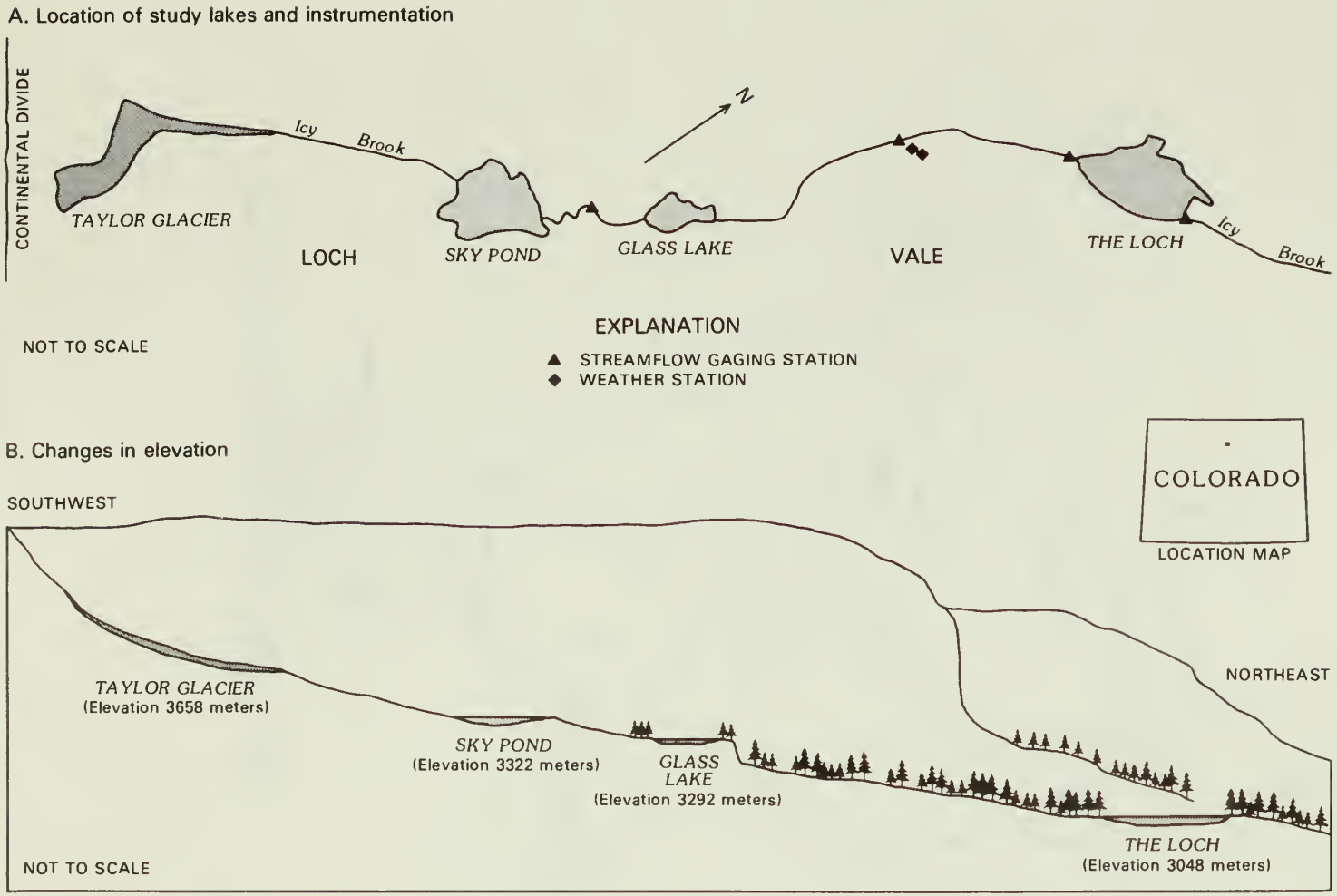

Figure 1.--Plan and cross-sectional views of the study area: *A*. Location of study lakes and instrumentation. *B*. Changes in elevation.

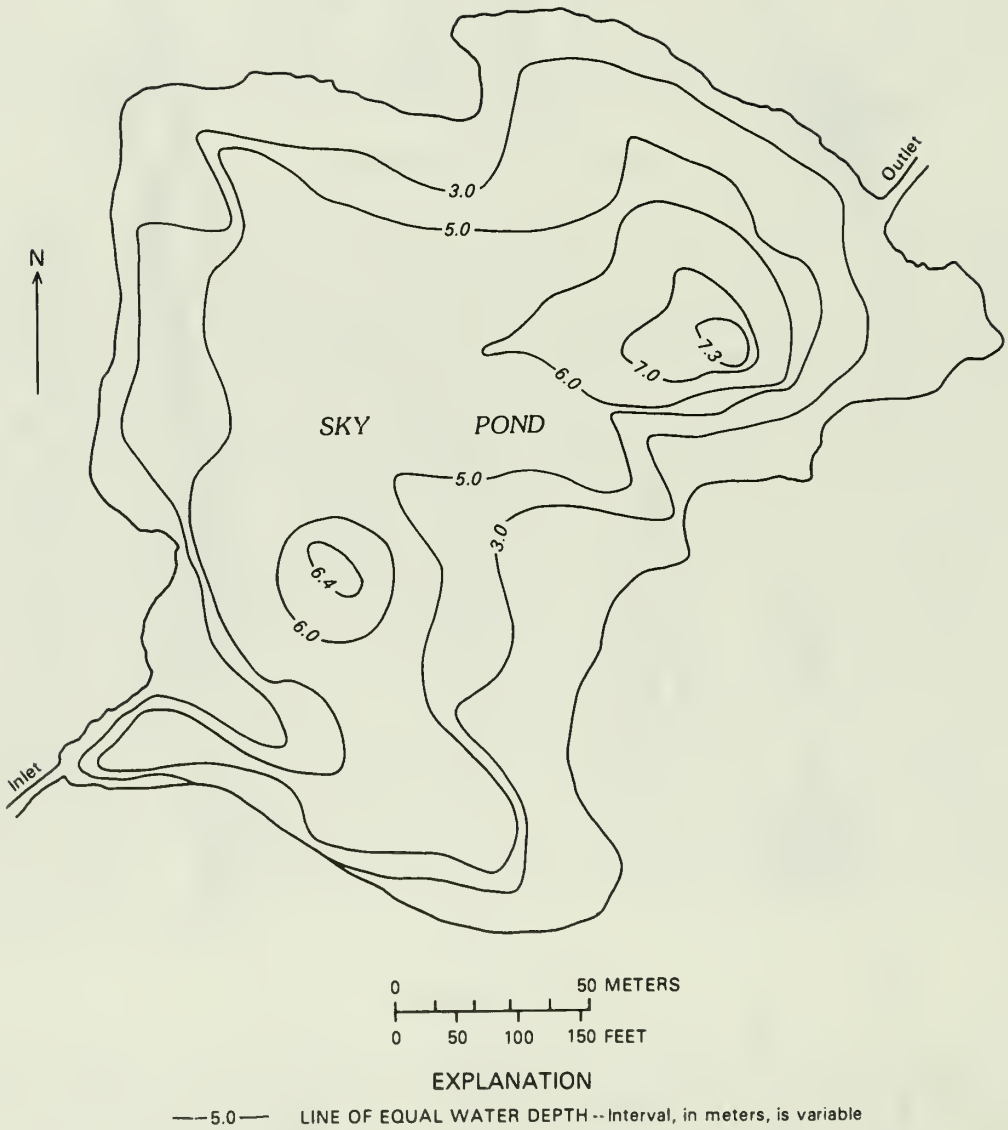

Figure 2.--Bathymetric map of Sky Pond.

Figure 3.--Bathymetric map of Glass Lake.

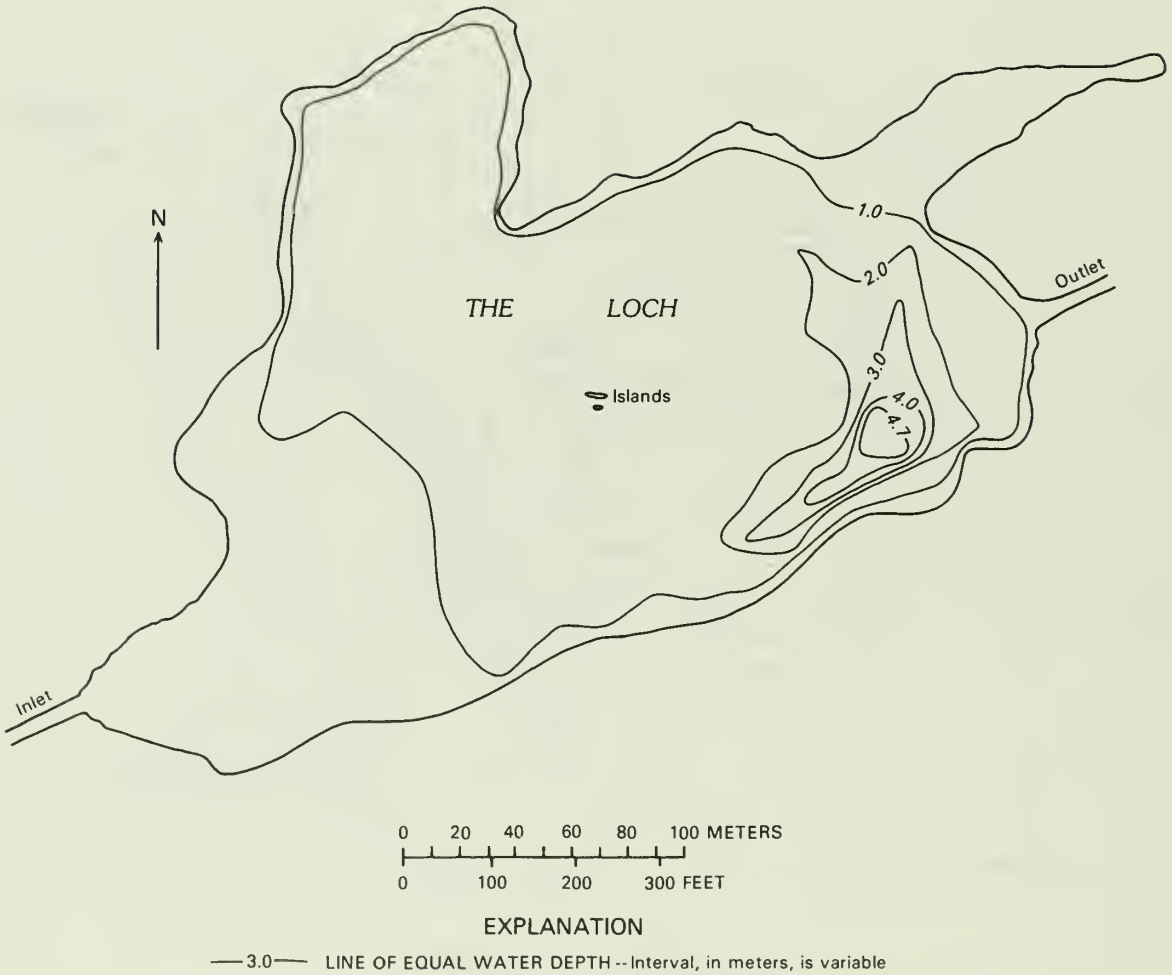

Figure 4.--Bathymetric map of The Loch.

Table 1.--*Morphometric characteristics of the study lakes*

[m, meters; ha, hectares; m^3, cubic meters]

Lake	Elevation (m)	Surface area (ha)	Lake volume (m^3)	Average depth (m)	Maximum depth (m)
Sky Pond	3,322	3.03	121,684	4.5	7.3
Glass Lake	3,292	1.01	25,690	2.8	4.7
The Loch	3,048	4.98	61,099	1.5	4.7

METHODS OF DATA COLLECTION AND ANALYSIS

Phytoplankton Populations

Discrete 1-L samples for determination of phytoplankton populations were collected at 3 depths in each lake using a VanDorn sampler[1]. Phytoplankton also were collected using a Wildco 40-mesh size, 12.7-cm diameter net; tows were made from a small rubber raft over the deepest area of each lake; phytoplankton from 2 or 3 tows were analyzed as one sample. The abundance of the phytoplankton was estimated, based on the number of tows, the depth of the tows, and the area of net opening, assuming all water above the net passed through the net during the tow. Lugol's solution was added promptly as a preservative to the discrete and tow samples. Algal species were identified and counted by Chadwick and Associates, Littleton, Colorado, using settling columns and an inverted microscope.

Chlorophyll a, Phaeopigments, and Fluorescence

Samples from the same three VanDorn depth samples used for the discrete photoplankton samples also were filtered through GFC glass-fiber filters for analysis of chlorophyll a concentrations by extraction in acetone with a correction for phaeopigments using the method described by Strickland and Parsons (1972). The fluorescence of the living phytoplankton was measured using a Turner Designs model-10 series fluorometer in water samples from 1-m depth intervals within a few hours of sample collection.

Nutrients and Other Chemical Constituents

Samples for chemical analysis were collected using a VanDorn sampler, and were filtered through 0.4 μm Nuclepore filters into 250 mL plastic bottles. Nitrate, nitrite, ammonia, and orthophosphate concentrations were determined by various colorometric methods, as described by Skougstad and others (1979). Color, pH, and silica, iron, calcium, and sulfate concentrations were determined by methods described by Skougstad and others (1979). Dissolved-organic-carbon (DOC) and suspended-organic-carbon (SOC) concentrations were determined using an Oceanographic International #524B-AA-303 Organic Carbon Analyzer. All analyses were performed by the U.S. Geological Survey central laboratory in Denver.

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[1]The use of trade names in this report is for identification only and does not constitute endorsement by the U.S. Geological Survey.

Selected Physical Characteristics

The intensity of photosynthetically active radiation (PAR: from 400 to 700 nm) and the temperature were measured at 0.5- or 1-m intervals in each lake, using a LI-COR lightmeter and a YS1 Model 51B temperature/dissolved-oxygen meter. The extinction coefficient (E) was calculated from light-intensity data with depth by using linear regression of the equation:

$$\ln I = \ln I_o + Ez \qquad (1)$$

where

I=PAR intensity, in lux;

I_o=PAR intensity at the lake surface, in lux;

E=extinction coefficient; and

z=depth, in meters.

SEASONAL CHANGES

One of the unique features of alpine and montane (subalpine) lakes and streams is a large increase in stream discharge during the spring snowmelt period. As indicated by the data for The Loch presented in table 2, during the spring and sometimes during the summer, the rate at which water is flushed from the lake increases to the point that almost all water in the lake is replaced every day. This rapid flushing rate is significant in terms of the dynamics of the resident phytoplankton populations. For the phytoplankton populations to maintain the same cell densities during this time of year, the algae must grow at a rate that matches the flushing rate, assuming that there is not a significant inflow of phytoplankton to the lake at the inlet. The algal growth rates necessary to match maximum flushing rates in the spring are close to one division per day, which is a very rapid growth rate compared with growth rates of algae grown in laboratory cultures under optimal light, temperature, and nutrient conditions.

Phytoplankton Populations

Seasonal changes in phytoplankton populations in 1-L discrete surface samples during the study period are summarized in table 3 for Sky Pond and table 4 for The Loch. The complete enumerations of algae in the 1-L discrete depth samples collected on different sampling dates are listed in tables 5-10 (spring and summer) and 11-13 (fall and winter) for Sky Pond, and in tables 14-21 (spring and summer) and 22-25 (fall and winter) for The Loch. The phytoplankton data from the net tows from all three lakes are presented in tables 26-33. Tables 5-33 are in the "Supplemental Data" section at the end of the report. Comparison of the data from the discrete samples with data from the net tows clearly indicates that the phytoplankton abundance is substantially underestimated by the net tows if the assumption is made that the volume filtered by the net tow was equal to the product of the entire depth of the water column and the area of the opening of the net. In all probability, the net clogged early on during the tows and water simply was displaced, rather than filtered, thereafter. Seasonal changes in the

Table 2.--*Stream discharge of Icy Brook at the outlet of The Loch, and flushing and residence times calculated for The Loch*

[m^3/s, cubic meters per second; d, days]

Sampling date	Discharge[1] (m^3/s)	Flushing rate (d^{-1})	Residence time (d)
5-16-84	0.27	0.38	2.6
5-23-84	.54	.77	1.3
6-5-84	.37	.53	1.9
6-13-84	.64	.90	1.1
6-20-84	.65	.91	1.1
6-27-84	.65	.91	1.1
7-3-84	.82	1.16	.9
7-17-84	.33	.47	2.1
7-25-84	.94	1.33	.8
8-6-84	.47	.67	1.5
8-15-84	.50	.70	1.4
8-30-84	.40	.57	1.8
9-13-84	.32	.45	2.2
10-11-84	.21	.30	3.3

[1]Average value for 24 hours was used.
[2]A constant lake volume of 61,099 cubic meters for the open-water period was assumed.

abundance of the major alga phyla in Sky Pond are presented in figure 5. From these data, three different periods can be identified: (1) A spring population peak that was dominated by diatoms, mainly *Asterionella formosa*, and some green algal species; (2) a midsummer population minimum, when diatom populations decreased 10- to 100-fold and green-algal populations increased; and (3) a fall population peak that was dominated by a filamentous blue-green alga, *Oscillatoria limnetica*.

Because of the greater cell volume of diatoms relative to blue-green algae, the spring diatom peak may correspond to a greater algal biomass than the fall blue-green algal peak. The same general pattern was observed in The Loch, with the exception that in The Loch filamentous blue-green algae were abundant in late May (5/23) and then decreased in abundance with the increase in the *Asterionella formosa* population. These blue-green algae may have bloomed under the ice and been flushed out of the lake with the spring snowmelt. The spring increase in the diatom populations indicates that these populations were growing at rates of about one division per day during this period of rapid flushing rates.

Examination of the data from the different depths indicates some interesting trends (tables 5-13 for Sky Pond and tables 14-25 for The Loch). In both lakes, the *Asterionella formosa* population had a uniform depth distribution during the summer; however, *A. formosa* had its greatest abundance

Table 3.--*Seasonal changes in phytoplankton in surface samples from Sky Pond, as collected in 1-liter discrete samples*

[m, major species; e, equally distributed among listed species; 13,100, cell density, in cells per milliliter]

Sampling date	Diatoms	Green algae	Chrysophytes (m. *Dinobryon divergens*)	Blue-green algae	Dino-flagellates
5-22-84	(m. *Asterionella formosa*)	(m. *Eudorina elegans*)	--	(*Aphanothece sp.*)	--
5-29-84	13,100 (m. *A. formosa*)	2,350 (m. *Nephrocytium limnetium*)	85	1,900 (m. *Oscillatoria limnetica*)	--
6-12-84	32,000 (m. *A. formosa*)	2,950 (m. *N. limneticum*)	--	680 (m. *O. limnetica*)	57 (m. *Peridinium inconspicua*)
6-26-84	6,300 (m. *A. formosa*)	1,000 (m. *Chlorella ellipsoidea*)	250	280 (m. *O. limnetica*)	--
7-10-84	1,200 (m. *A. formosa*)	2,700 (e. *Chlamydomonas* sp., *Octosporiella coloradensis*; and *Chlorella ellipsoidea*)	--	7,100 (m. *O. limnetica*)	28 (m. *P. inconspicua*)
7-24-84	530 (m. *A. formosa*)	9,949 (m. *C. elliposoidea*)	312	13,350 (m. *O. limnetica*)	--
8-14-84	511 (m. *A. formosa*)	12,300 (m. *C. elliposoidea*)	--	58,700 (m. *O. limnetica*)	--
9-11-84	200 (m. *A. formosa*)	2,300 (e. *Chlamydomonas* sp., *Pandorina morum*, and *Chlorococum infusionum*)	--	160,200 (m. *O. limnetica*)	--
10-9-84	300 (m. *A. formosa*)	3,600 (m. *Chlamydomonas*)	--	197,400 (m. *O. limonetica*)	57 (m. *P. inconspicua*)
12-4-84	-- (m. *A. formosa*)	-- (m. *Chlamydomonas*)	-- (m. *Dinobryon cylindricum*)	-- (m. *O. limnetica*)	--
1-22-85	(32,000 in hypolimnion, m. *A. formosa*)	1,400	1,700 (m. *D. cylindricum*)	--	--

Table 4.--*Seasonal changes in phytoplankton in surface samples from The Loch, as collected in 1-liter discrete samples*

[m, major species; e, equally distributed among listed species; 880, cell density, in cells per milliliter]

Sampling date	Diatoms	Green algae	Chrysophytes (m. *Dinobryon divergens*)	Blue-green algae	Dino-flagellates
5-23-84	880 (m. *Asterionella formosa*)	400	200	14,700 (m. *Microcystis* sp. and *Aphanothece* sp.)	--
6-5-84	2,900 (m. *A. formosa*)	1,020 (distributed)	--	170 (m. *Chroococcus limneticus*)	--
6-13-84	-- (m. *A. formosa*)	-- (m. *E. elegans*)	--	--	--
6-20-84	3,400 (m. *A. formosa*)	600 (m. *Chlamydomonas* sp.)	28	--	--
6-27-84	2,200 (m. *A. formosa*)	350 (m. *Chlamydomonas* sp.)	--	--	--
7-3-84	860 (m. *A. formosa*)	790 (distributed)	85	85 (m. *C. limneticus*)	--
7-17-84	-- (e. *Melosira lirata* and *A. formosa*)	--	--	--	--
7-25-84	260 (m. *A. formosa*)	1,530 (distributed)	--	600 (m. *Oscillatoria limnetica*	--
8-15-84	28 (m. *Navicula schassmanic*)	5,140 (m. *Chlamydomonas*)	--	200 (m. *Anabaena* sp.)	--
8-30-84	70 (m. *Fragilaria pinnata*)	6,034 (m. *Chlorella* sp.)	--	230 (m. *O. limnetica*)	--
9-13-84	19 (m. *A. formosa*)	2,500 (m. *Gonium* sp.)	--	20,300 (m. *O. limnetica*)	--
10-11-84	28 (m. *A. formosa*)	1,200 (distributed)	--	8,800 (m. *O. limnetica*)	--
12-6-84	340 (m. *Diatoma hiemale*)	910 (distributed)	230 (m. *Dinobryon cylindricum*)	795 (m. *O. limnetica*)	230 (m. *Peridinium* sp.)
1-22-85	1,590 (m. *A. formosa*)	400 (m. *Chlorococcum*)	230 (m. *D. cylindricum*)	2,590 (m. *C. limneticus*)	28 (m. *Peridinium bipes*)

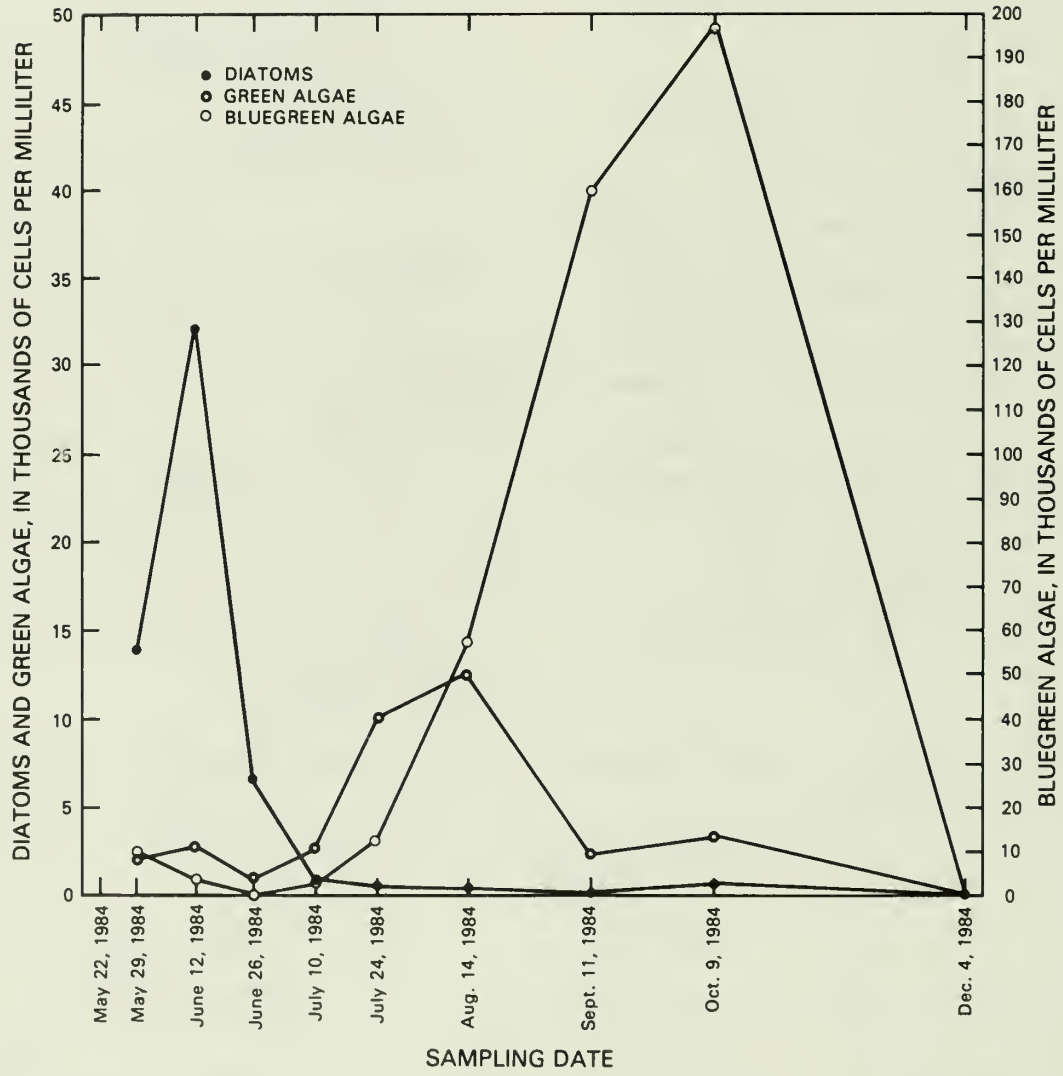

Figure 5.--Seasonal changes in phytoplankton populations in Sky Pond (see table 3).

at depth in the winter and in the first sample in May. Green algae were represented by the most species in both Sky Pond and The Loch; the distribution of different species with depth was variable. Another similarity in the data sets for Sky Pond and The Loch is the peak abundance of *Oscillatoria limnetica* in September (table 11 for Sky Pond and table 22 for The Loch). In both lakes, large differences in abundance between depths were observed; however, the location of the greatest abundance varied between lakes and sampling dates.

Concentrations of Chlorophyll a and Phaeopigment, and Fluorescence

The chlorophyll a and phaeopigment concentrations, as measured by extraction of glass-fiber filters, and the fluorescence of living phytoplankton are listed for the different sampling dates in table 34 for Sky Pond and in table 35 for The Loch in the "Supplemental Data" section at the end of the report. Seasonal changes in extracted chlorophyll a concentration in surface samples from Sky Pond are shown in figure 6. Comparison of figures 5 and 6 indicates that the same seasonal pattern occurred for algal abundance and chlorophyll a concentrations and provides further evidence of a greater algal biomass associated with the early spring diatom bloom than with the fall blue-green algal bloom. Little correspondence appears to occur between the extracted chlorophyll a concentration and the fluorescence data, either for the period of study, or for different depths on a single sampling date. The relation between the cellular chlorophyll a content and the fluorescence of living phytoplankton is known to vary significantly among algal species, and with changes in physiological status for a single algal species (Alpine and Cloern, 1985). Therefore the failure to observe a well-defined relation between these two characteristics in this study is consistent with the recorded changes in the phytoplankton-species composition.

Chlorophyll a concentrations measured in Sky Pond and The Loch are similar in magnitude to those measured by Ellsworth (1983) in another small Colorado mountain lake during the same season. Toetz and Windell (1983) measured chlorophyll a concentrations in 7 lakes in the nearby Green Lakes Valley in August; they measured concentrations of chlorophyll a ranging from 0.5 to 10 µg/L (micrograms per liter), which is comparable to the range measured in Loch Vale lakes during August.

Concentrations of Nutrients and Other Chemical Constituents

Concentrations of nutrients and other chemical constituents are listed in table 36 for Sky Pond and in table 37 for The Loch. Seasonal changes in nitrate and orthophosphate concentrations in Sky Pond are shown in figure 7. Throughout the open-water period of this study, nutrient concentrations virtually were uniform with depth, which fact is explained by lack of temperature stratification in these lakes (fig. 8). Therefore, nutrients released from lake sediments would be available to phytoplankton in the water column. In both Sky Pond and The Loch, during the winter, under ice-cover, steep concentration gradients with depth occurred for several nutrients, with the greatest nitrate conentrations at the surface, and the greatest orthophosphate and iron concentrations at depth. These gradients may have reflected anaerobic microbial processes occurring in the lake sediments or in the

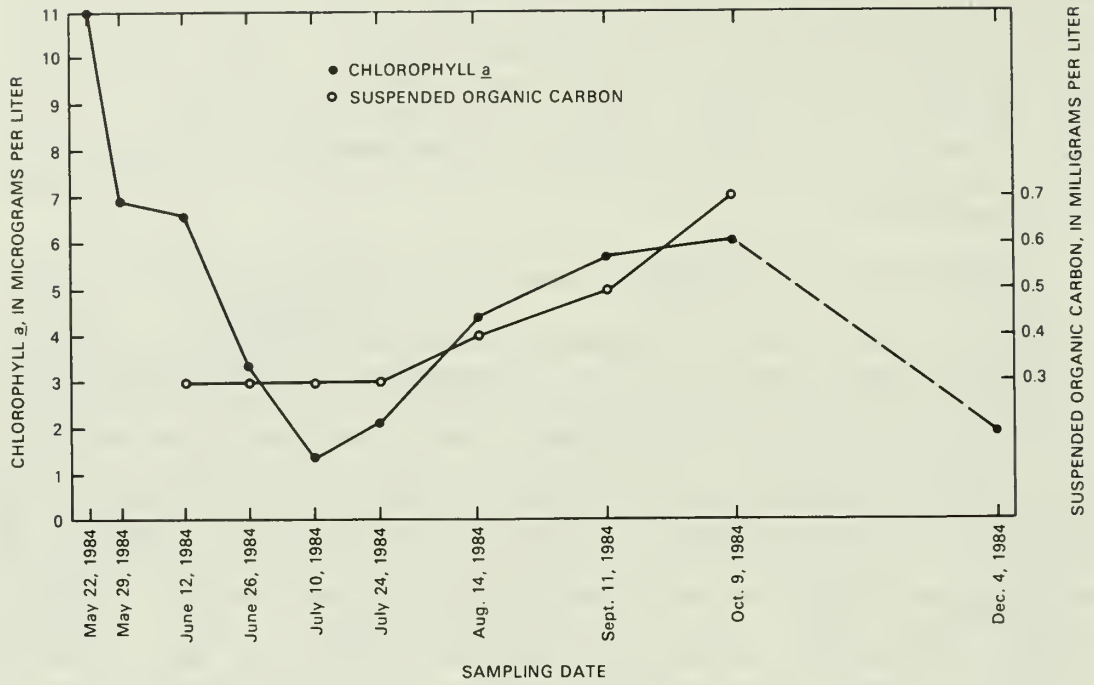

Figure 6.--Seasonal changes in chlorophyll a and suspended-organic-carbon concentrations in surface samples from Sky Pond (see table 34 and 39).

bottom waters. In early May, the concentration maximum in nitrate at the surface increased in magnitude, which was consistent with inflow of nitrate-enriched water from shallow subsurface runoff travelling under the snowpack, as snowmelt began. Development of this peak in surface nitrate concentration appeared to be delayed in Sky Pond, relative to The Loch, which is at a lower elevation.

The spring increase in nitrate concentration extended to depth as the lakes became ice-free, with the continuing spring runoff. Similar seasonal trends in nitrate concentration were determined in previous years of the study at Loch Vale. This trend of increasing nitrate concentrations with discharge in the spring runoff period is the opposite of the trend of decreasing spring nitrate concentrations determined by Lewis and Grant (1979) in Como Creek, a small Rocky Mountain stream draining a watershed only 40 km south of the Loch Vale area. However, the nitrate concentrations Lewis and Grant (1979) measured in Como Creek were in the range of 1 to 7 µg/L, more than 2 orders of magnitude less than those in Loch Vale surface waters. Toetz and Windell (1983, and written commun., 1984) measured nitrate concentrations in Albion Lake in the Green Lakes system ranging from 45 to 700 µg/L in the summers of 1983 and 1984, which is a more limited but comparable range to that measured in Loch Vale lakes.

Halterman and Toetz (1984) studied the kinetics of nitrate uptake by many freshwater algal species. They determined that several diatom species had half-saturation coefficients (K_s) for nitrate of 2.5 to 7 µ*M* (micromolar) which were about the maximum for all algal species studied. If the

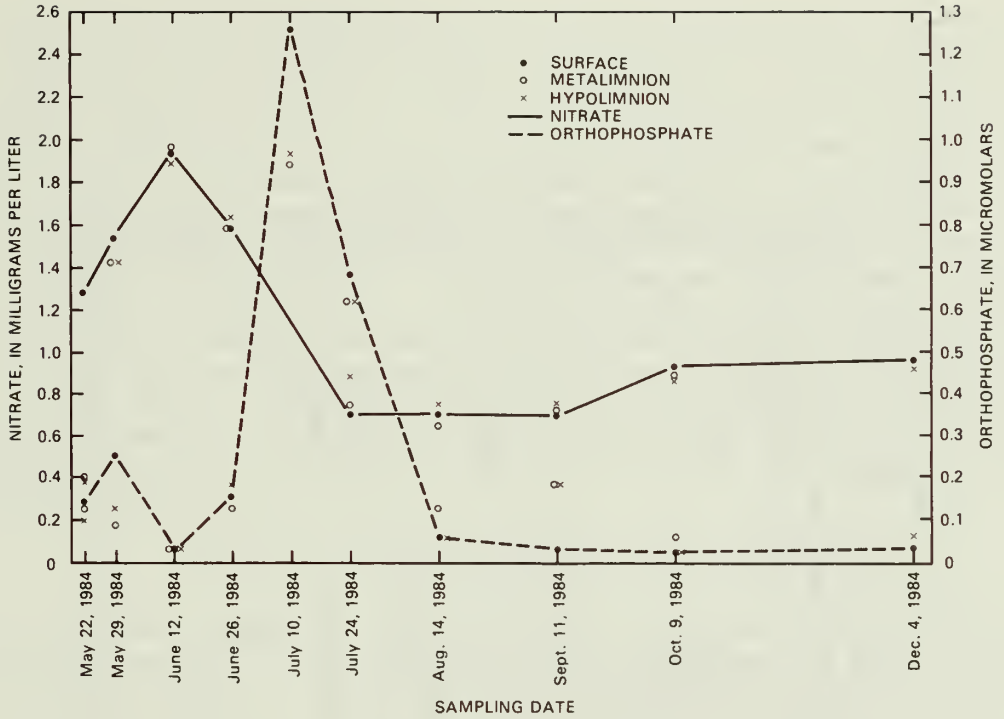

Figure 7.--Seasonal changes in nitrate and orthophosphate concentration in Sky Pond (see table 36).

Asterionella formosa populations in these lakes had K_s values of 7 to 10 μ*M*, the spring increase in nitrate concentration, from 221 μg/L (3.5 μ*M*) on May 8, 1984, to 1,950 μg/L (31.5 μ*M*) on June 6, 1984, in Sky Pond, would result in an increased rate of nitrate uptake, if the concentrations of other nutrients were not limiting the growth of *A. formosa*. The enhanced nitrate uptake rates may have been an important factor in the rapid growth rates necessary to account for the increases in diatom abundance that occur during the periods of rapid flushing rates in the spring. The significance of these rapid flushing rates for alpine lakes was discussed by Keefer and Pennak (1977), who determined that 99 percent of the plankton in Long Lake, Colorado, was flushed out by excessive June runoff. A possibility also exists that increased nitrate concentrations are related to lower temperature optima for algal photosynthesis and respiration (Priscu and Goldman, 1984). Therefore, the nitrate peak may be a causal factor in the spring diatom-population peak (comparison of figs. 5 and 7).

During midsummer, the concentrations of dissolved orthophosphate increased substantially. With the exception of higher orthophosphate concentrations in July, the low concentrations of dissolved orthophosphate in Sky Pond and The Loch were similar to concentrations in lakes in the Green Lakes Valley (Toetz and Windell, 1983) and in Como Creek (Lewis and Grant, 1979). Phosphate may have been a limiting nutrient in these lakes. However, the increase in orthophosphate in July during midsummer phytoplankton minimum indicated that the decrease in phytoplankton abundance was not a result of phosphate depletion, but, conversely, that the increase in phosphate was a

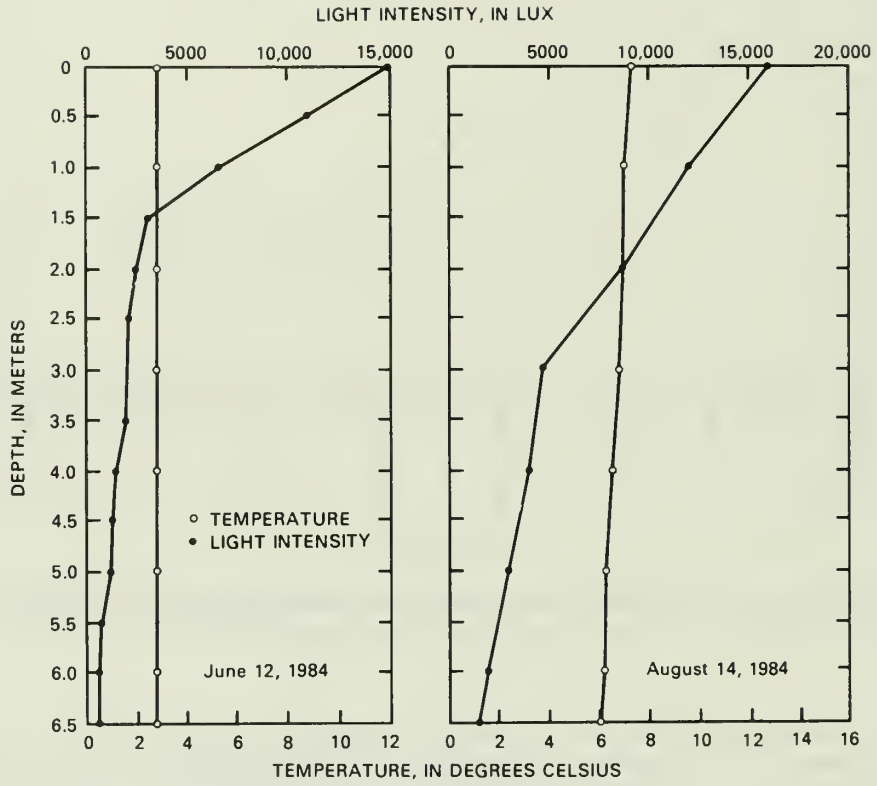

Figure 8.--Temperature and light-intensity profiles in Sky Pond during spring snowmelt (June 12, 1984) and midsummer (August 14, 1984)(see table 40).

result of phytoplankton decrease. This result further indicated that the phytoplankton decrease was caused by another process, such as zooplankton grazing or photoinhibition. Without additional data, both processes are considered as equally possible. Ellsworth (1983) determined maximum zooplankton abundance in midsummer in a study of another Colorado mountain lake. Fabris and Hammer (1975) determined maximum photosynthetic rates at depth in high-altitude lakes in the Canadian Rocky Mountains.

The silica concentration in Sky Pond generally was between 0.5 and 1.5 mg/L (milligrams per liter); the silica concentration in The Loch was somewhat larger, between 1.5 and 3.0 mg/L. At these concentrations, silica limitation of diatom growth was unlikely to be a factor in the ecology of these lakes. A decrease in silica concentration occurred in both lakes during the spring snowmelt period. This decrease may have been a result of hydrologic factors, such as dilution of dissolved silica by snowmelt, or, possibly, the decrease may have been a result of the concurrent peak in diatom abundance.

The DOC and SOC concentrations in the Sky Pond and The Loch are listed in tables 38 and 39 in the "Supplemental Data" section at the end of the report. DOC concentrations in these two lakes consistently were less than 1.0 mg C/L (milligrams carbon per liter). The trend of decreasing DOC through the summer probably was related to the decreasing surface runoff entering these lakes. For both lakes, DOC concentrations were very similar at all sampling depths. The minimum DOC concentrations were in samples from the small inlet to Sky Pond during snowmelt and the maximum DOC concentrations were in samples from a small stream entering The Loch. The SOC concentrations also were low, and were comparable in magnitude to DOC concentrations. As shown in figure 6, for Sky Pond, the increase in SOC concentrations in the fall appeared to parallel the increase in chlorophyll *a* associated with the blue-green algal peak. In The Loch, no relation between SOC and chlorophyll *a* concentrations was apparent, which can be interpreted as indicating that the lesser algal abundance in The Loch, relative to Sky Pond, does not contribute significantly to the SOC in The Loch.

Values of Selected Physical Characteristics

Data for pH, temperature, and intensity of PAR are listed in table 40 for Sky Pond and in table 41 for The Loch in the "Supplemental Data" section at the end of the report. Temperature and light profiles in Sky Pond during the peak in diatom abundance (6-12-84), and during the midsummer minimum in algal abundance (8-14-84), are presented in figure 8. These data indicate that the attenuation of PAR with depth is less during midsummer than during the spring or fall. The decrease in light attenuation can be quantified by fitting the data in tables 40 and 41 to the following equation:

$$I=I_o e^{Ez} \quad . \qquad (2)$$

The extinction coefficient and Secchi depth in Sky Pond during the period of study are shown in figure 9 and are compared with measurements of color by comparison with standard platinum solutions in table 42 in the "Supplemental Data" section at the end of the report.

Two explanations are possible for the seasonal change in extinction coefficient: (1) At the end of the spring runoff period, the extinction coefficient decreased because of settling of suspended material and decreases in concentration of humic substances in lake inflow, at which point the greater light intensity at depth caused a decrease in photosynthesis rate (photoinhibition) and in phytoplankton abundance; or (2) the extinction coefficient primarily was affected by the phytoplankton abundance, and, in midsummer, some other factor, such as zooplankton grazing, decreased the phytoplankton abundance and caused the extinction coefficient to decrease concurrently.

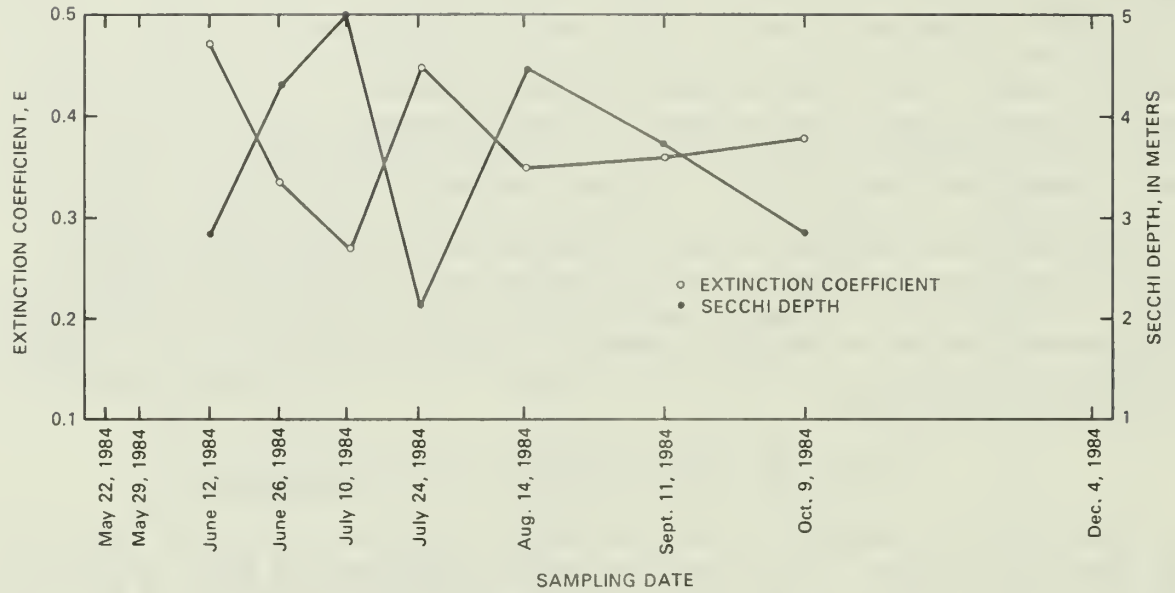

Figure 9.--Seasonal changes in extinction coefficient and Secchi depth in Sky Pond.

SUMMARY

The purpose of the study reported here was to identify important seasonal changes in the phytoplankton populations in Loch Vale lakes in order to design experiments to study the effects of potential nitrate-concentration increases resulting from acid rain. Three periods were identified in the phytoplankton succession in the lakes: (1) A spring diatom bloom; (2) a midsummer algal minimum; and (3) a fall blue-green algal bloom.

Although the seasonal changes in phytoplankton populations in the Loch Vale lakes resembled the general pattern observed in temperate lakes, these lakes are probably different in several ways from temperate lakes at lower elevations. Thermal stratification in the summer did not occur; therefore, the summer decrease in phytoplankton abundance was most likely a result of zooplankton grazing or photoinhibition, and not a result of phosphate depletion as occurs in typical temperate lakes. In fact, phosphate concentrations increased during the decrease in phytoplankton, indicating that the lake bottom or the dead phytoplankton are a source of phosphate at this time. The spring diatom bloom occurred at times of rapid flushing rates, resulting from rapid melting of the substantial snowpack. The diatom bloom during a period of rapid flushing rates implies a rapid phytoplankton growth rate. Rapid growth rate, in turn, may have been stimulated by the concurrent two-fold increase in nitrate concentrations, if the nitrate-uptake kinetics of the diatom populations in the Loch Vale lakes are similar to those of freshwater diatoms studied by Halterman and Toetz (1984).

REFERENCES

Alpine, A. E., and Cloern, J. E., 1985, Differences in *in vivo* fluorescence yield between three different phytoplankton size classes: Journal of Plankton Research, v. 7, no. 3, p. 381-390.

Church, M. R., and Galloway, J. N., 1984, Application of Henriksen's "Acidification indicator" and "Predictor nomograph" to two Adirondak lakes: Water, Air, and Soil Pollution, v. 22, p. 111-120.

Devol, A. H., and Wissmar, R. C., 1978, Analysis of five North American lake ecosystems, V. Primary production and community structure: Verhandlungen Internationale Vereinigung fuer theoretische und angewandte Limnologie, v. 20, p. 581-556.

Ellsworth, P. M., 1983, Ecological seasonal cycles in a Colorado mountain pond: Journal of Freshwater Ecology, v. 2, no. 3, p. 225-237.

Fabris, G. L., and Hammer, U. T., 1975, Primary production in four small lakes in the Canadian Rocky Mountains: Verhandlungen Internationale Vereinigung fuer theoretische und angewandte Limnologie, v. 19, p. 530-541.

Fee, E. J., 1973, A numerical model for determining integral primary production and its application to Lake Michigan: Journal of Fisheries Research Board of Canada, v. 30, no. 10, p. 1447-1468.

Grant, M. C., and Lewis, W. M., Jr., 1982, Chemical loading rates from precipitation in the Colorado Rockies: Tellus, v. 34, p. 74-88.

Halterman, S. G., and Toetz, D. W., 1984, Kinetics of nitrate uptake by freshwater algae: Hydroibiologia, v. 114, p. 209-214.

Keefer, V. M., and Pennak, R. W., 1977, Plankton and seston of a Colorado (U.S.A.) alpine lake--The winter anomaly and the inlet-outlet budget: Internationale Revue der gesamten Hydrobiologie, v. 62, no. 2, p. 255-278.

Kling, G. W., and Grant, M. C., 1984, Acid precipitation in the Colorado Front Range--An overview with time predictions for significant effects: Arctic and Alpine Research, v. 16, no. 3, p. 321-329.

LaZerte, B. D., and Dillon, P. J., 1984, Relative importance of anthropogenic verus natural sources of acidity in lakes and streams of central Ontario: Canadian Journal of Fisheries and Aquatic Sciences, v. 41, no. 11, p. 1664-1677.

Lewis, W. M., Jr., and Grant, M. C., 1979, Relationships between stream discharge and yield of dissolved substances from a Colorado mountain watershed: Soil Science, v. 128, no. 6, p. 353-363.

Lewis, W. M., Jr., Grant, M. C., and Saunders, J. F., III, 1984, Chemical patterns of bulk atmospheric deposition in the State of Colorado: Water Resources Research, v. 20, no. 11, p. 1691-1704.

Likens, G. E., and Loucks, O. L., 1978, Analysis of five North American lake ecosystems, III. Sources, loading and fate of nitrogen and phosphorus: Verhandlungen Internationale Vereinigung fuer theoretische und angewandte Limnologie, v. 20, p. 568-573.

Pennak, R. W., 1963, Rocky Mountain States, David, G. F., ed., *in* Limnology in North America: Madison, University of Wisconsin Press, p. 349-370.

Priscu, J. C., and Goldman, C. R., 1984, The effect of temperature on photosynthetic and respiratory electron transport system activity in the shallow and deep-living phytoplankton of a subalpine lake: Freshwater Biology, v. 14, p. 143-155.

Schindler, D. W., and Holmgren, S. K., 1971, Primary production and phytoplankton in the experimental lakes area, northwestern Ontario, and other low-carbonate waters, and a liquid scintillation method for determining ^{14}C activity in photosynthesis: Journal of Fisheries Research Board of Canada, v. 28, no. 2, p. 189-201.

Schindler, D. W., Schmidt, R. V., and Reid, R. A., 1972, Acidification and bubbling as an alternative to filtration in determining phytoplankton production by the ^{14}C method: Journal of Fisheries Research Board of Canada, v. 29, no. 11, p. 1627-1631.

Skougstad, M. W., Fishman, M. J., Friedman, L. C., Erdmann, D. E., and Duncan, S. S., eds, 1979, Methods of or determination of inorganic substances in water and fluvial sediments: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 5, Chapter A1, 626 p.

Stainton, M. P., 1973, A syringe gas-stripping procedure for gas-chromatographic determination of dissolved inorganic and organic carbon in fresh water and carbonates in sediments: Journal of Fisheries Research Board of Canada, v. 30, no. 10, p. 1441-1445.

Strickland, J. D. H., and Parson, T. R., 1972, A practical handbook of seawater analysis (2d ed.): Ottawa, Fisheries Research Board of Canada Bulletin 167, 310 p.

Tilzer, Max, 1972, Bacterial productivity of a high-mountain lake: Verhandlungen Internationale Vereinigung fuer theoretische und angewandte Limnologie, v. 18, p. 188-196.

Toetz, D. W., and Windell, J. T., 1983, Lake productivity: Boulder, Colorado, Report for 1983 to Institute of Arctic and Alpine Research, 14 p.

SUPPLEMENTAL DATA

Table 5.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, May 29, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	85	57	--
Order Pennales			
Achnanthes linearis	57	--	--
Asterionella formosa	20,107	15,535	13,092
Fragilaria crotonensis	170	--	57
Synedra rumpens	--	28	--
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	256	114	142
Chlamydomonas sp. 1	28	--	--
Chlorogonium sp.	85	--	57
Closterium sp.	--	57	--
Eudorina elegans	568	511	--
Gloeococcus tetrasporus	--	227	--
Gonium sp.	--	--	85
Nephrocytium limneticum	4,004	2,925	1,079
Octosporiella coloradensis	--	114	256
Pandorina smithii	--	909	--
Scenedesmus sp.	511	341	369
Ulothrix sp.	--	341	454
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	28	28	85
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	284	--	1,505
Chroococcus sp.	28	114	369
Oscillatoria limnetica	625	--	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	3,465	1,676	170
Cryptomonas sp.	--	28	--
Total cells per milliliter	30,301	23,005	17,720
Number of species	15	16	13

Table 6.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, June 12, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	454	--	--
Order Pennales			
Asterionella formosa	26,639	30,502	30,786
Fragilaria pinnata	--	--	398
Synedra rumpens	284	170	341
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	170	--	227
Chlamydomonas sp. 1	--	114	--
Chlorella ellipsoidea	341	398	227
Chlorococcum sp.	--	57	--
Closterium sp.	--	114	--
Gonium sp.	170	--	398
Nephrocytium limneticum	2,840	1,477	1,704
Octosporiella coloradensis	284	682	170
Scenedesmus sp.	341	341	227
Schroederia setigera	57	682	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	199	--	--
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	454	--	--
Oscillatoria limnetica	--	909	682
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	--	--	57
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	3,010	3,238	1,988
Cryptomonas ovata	57	--	--
Total cells per milliliter	35,300	38,684	37,205
Number of species	14	12	12

Table 7.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, June 26, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	227	--	--
Order Pennales			
Asterionella formosa	6,674	7,270	6,248
Synedra rumpens	256	170	114
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	227	57	142
Chlamydomonas sp. 1	227	85	228
Chlamydomonas sp. 2	142	28	57
Chlorella ellipsoidea	738	966	511
Closterium sp.	85	57	57
Gloeococcus tetrasporus	85	85	28
Gonium sp.	--	--	57
Nephrocytium limneticum	142	85	28
Octosporiella coloradensis	--	57	--
Scenedesmus sp.	--	170	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	909	426	256
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	142	--	--
Oscillatoria limnetica	909	--	284
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	1,818	1,619	1,704
Cryptomonas marsonii	57	--	28
Total cells per milliliter	12,638	11,075	9,742
Number of species	15	13	14

Table 8.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, July 10, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	28	--	--
Melosira lirata	170	--	--
Order Pennales			
Asterionella formosa	1,221	1,505	1,164
Diatoma niemale var. *mesodon*	--	28	--
Fragilaria crotonensis	--	57	--
Navicula schmassmannii	28	--	--
Synedra radians	--	28	85
Synedra rumpens	57	--	--
Synedra rumpens var. *familiaris*	--	--	57
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	28	--	--
Chlamydomonas sp. 1	170	57	1,051
Chlamydomonas sp. 2	114	511	85
Chlamydomonas sp. 3	--	142	426
Chlorella ellipsoidea	4,487	3,749	369
Gloeococcus tetrasporus	--	28	--
Gonium sp.	142	--	568
Octosporiella coloradensis	114	568	312
Scenedesmus sp.	57	57	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	852	1,278	--
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	--	114	--
Dactylococcopsis acicularis	28	85	85
Oscillatoria limnetica	3,522	2,755	7,128
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	--	28	28
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	511	1,079	284
Rhodomonas minuta	--	--	256
Total cells per milliliter	11,529	12,069	11,898
Number of species	16	17	14

Table 9.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, July 24, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	28	--	85
Order Pennales			
Asterionella formosa	683	1,306	483
Fragilaria pinnata	57	--	--
Synedra radians	--	114	57
Synedra rumpens var. *familiaris*	--	170	--
CHLOROPHYTA (Green algae)			
Ankistrodesmus facatus var. *acicularis*	--	57	--
Chlamydomonas sp. 1	199	2,442	341
Chlamydomonas sp. 2	483	398	824
Chlamydomonas sp. 3	540	738	596
Chlorella ellipsoidea	4,004	21,300	7,924
Chlorococcum infusionum	--	--	28
Eudorina elegans	1,903	966	85
Gonium sp.	28	227	85
Spirogyra sp.	57	--	--
Zoospores	142	--	57
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	170	114	312
CYANOPHYTA (Blue-green algae)			
Oscillatoria limnetica	8,350	29,422	13,348
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	85	--	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	--	114	--
Total cells per milliliter	16,699	57,368	24,225
Number of species	14	13	13

Table 10.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, August 14, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
Asterionella formosa	707	682	511
Navicula schmassmannii	28	--	--
Synedra radians	114	--	--
Synedra rumpens var. *familiaris*	--	57	57
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	398	1,250	170
Chlamydomonas sp. 2	1,250	114	2,357
Chlamydomonas sp. 3	568	114	85
Chlorella ellipsoidea	9,315	7,668	8,974
Chlorococcum infusionum	3,324	682	--
Eudorina elegans	--	--	511
Gonium sp.	284	170	--
Scenedesmus sp.	--	--	57
Zoospores	--	170	142
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	710	--	540
Oscillatoria limnetica	29,337	31,354	58,731
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	85	57	28
Total cells per milliliter	46,120	42,318	72,163
Number of species	12	11	12

Table 11.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, September 11, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	28	--	57
Order Pennales			
Asterionella formosa	57	341	85
Synedra rumpens	--	--	57
Synedra rumpens var. *familiaris*	28	57	--
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	28	966	284
Chlamydomonas sp. 2	--	568	85
Chlamydomonas sp. 3	--	--	28
Chlorococcum infusionum	341	--	312
Gonium sociale	--	398	--
Gonium sp.	880	227	511
Pandorina morum	--	682	1,079
Scenedesmus sp.	57	114	--
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	--	--	114
Oscillatoria limnetica	371,023	315,341	160,233
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	227	114	--
Rhodomonas minuta	--	114	28
Total cells per milliliter	372,669	318,922	162,873
Number of species	9	11	12

Table 12.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, October 9, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	--	57	--
Order Pennales			
Asterionella formosa	114	114	312
Synedra rumpens var. *familiaris*	114	114	57
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	1,448	3,578	2,755
Chlamydomonas sp. 2	85	398	767
Chlamydomonas sp. 3	--	57	--
Chlorococcum infusionum	1,931	--	14
Cosmarium sp.	--	--	57
Eudorina elegans	284	--	--
Gonium sp.	284	--	114
Nephrocytium limneticum	28	57	--
Scenedesmus sp.	--	227	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	--	--	28
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	170	114	--
Oscillatoria limnetica	264,688	453,636	197,437
Synechococcus linearis	--	--	28
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	--	--	57
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	625	114	312
Rhodomonas minuta	--	57	--
Total cells per milliliter	269,771	458,523	201,938
Number of species	11	12	12

Table 13.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from Sky Pond, January 22, 1985*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
Asterionella formosa	32,092	114	--
Syndera rumpens var. *familiaris*	28	--	--
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	568	170	28
Chlamydomonas sp. 1	114	28	682
Chlorogonium sp.	--	--	28
Chlorococcum sp.	3,493	--	--
Nephrocytium sp.	199	1,732	682
Scenedesmus sp.	227	57	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon cylindricum var. *alpinum*	1,619	1,818	28
Unicellular flagellate	--	--	227
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	85	1,136	--
Total cells per milliliter	38,425	5,055	1,675
Number of species	9	7	6

Table 14.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, May 23, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	57	--	--
Order Pennales			
Asterionella formosa	3,578	824	880
Pinnularia borealis	--	--	28
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	57	114	28
Ankistrodesmus nannoselene	--	114	256
Chlamydomonas sp. 1	--	--	57
Chlamydomonas sp. 2	57	199	--
Chlorogonium sp.	57	--	--
Eudorina elegans	--	852	--
Oocystis sp.	--	28	--
Scenedesmus sp.	909	57	57
Schroederia setigera	--	--	28
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	114	57	--
Unicellular flagellate	--	385	199
CYANOPHYTA (Blue-green algae)			
Aphanothece sp.	18,627	20,107	11,076
Chroococcus limneticus	227	--	--
Chroococcus sp.	852	--	227
Lyngbya nana	682	--	--
Microcystis sp.	--	--	3,408
Oscillatoria augustissima	568	--	--
Oscillatoria limnetica	--	85	--
Oscillatoria sp.	--	398	--
Synechococcus elogatus	--	7,100	85
Synechococcus linearis	114	1,761	--
Synechocystis sp.	4,317	--	142
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	284	--	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	114	28	170
Cryptomonas sp.	341	28	--
Total cells per milliliter	30,955	32,137	16,641
Number of species	17	16	14

Table 15.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, June 13, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
Melosira lirata	227	--
Order Pennales		
Asterionella formosa	2,840	2,868
Meridion circulare	--	28
Navicula viridula	28	--
CHLOROPHYTA (Green algae)		
Ankistrodesmus falcatus var. *acicularis*	28	57
Ankistrodesmus nannoselene	28	227
Chlamydomonas sp. 1	568	227
Chlamydomonas sp. 2	57	142
Chlorogonium sp.	--	57
Eudorina elegans	426	--
Gloeococcus tetrasporus	341	--
Gonium sp.	--	28
Octosporiella coloradensis	256	170
Scenedesmus sp.	57	114
CHRYSOPHYTA (Golden-brown algae)		
Dinobryon divergens	--	426
CYANOPHYTA (Blue-green algae)		
Chroococcus limneticus	199	170
CRYPTOPHYTA (Cryptomonads)		
Cryptomonas sp.	--	170
Rhodomonas minuta	57	57
Total cells per milliliter	5,112	4,741
Number of species	13	14

Table 16.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, June 20, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	--	28	57
Melosira lirata	227	--	--
Order Pennales			
Asterionella formosa	5,566	3,436	3,436
Navicula minima	--	28	--
Navicula pseudoscutiformis	28	--	--
Synedra radians	28	28	--
Synedra rumpens	--	28	28
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	28	57	57
Ankistrodesmus nannoselene	85	--	114
Chlamydomonas sp. 1	454	738	369
Chlamydomonas sp. 2	114	--	28
Chlorella ellipsoidea	--	284	--
Eudorina elegans	--	57	--
Gonium sp.	--	28	--
Octosporiella coloradensis	284	--	28
Scenedesmus sp.	57	114	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	--	57	--
Unicellular flagellate	--	--	28
CYANOPHYTA (Blue-green algae)			
Aphanocapsa delicatissima	1,221	--	--
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	28	--	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	284	57	483
Rhodomonas minuta	--	57	--
Total cells per milliliter	8,404	5,054	4,628
Number of species	13	15	10

Table 17.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, June 27, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
Asterionella formosa	1,179	5,112	2,215
Navicula notha	--	--	28
Synedra radians	--	57	28
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	--	57	57
Ankistrodesmus nannoselene	--	227	--
Chlamydomonas sp. 1	142	114	227
Chlamydomonas sp. 2	--	170	28
Chlorogonium sp.	--	57	--
Closterium sp.	--	57	--
Eudorina elegans	170	1,590	--
Octosporiella coloradensis	--	57	--
Scenedesmus sp.	28	114	57
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	71	284	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	185	568	341
Total cells per milliliter	1,775	8,464	2,981
Number of species	6	13	8

Table 18.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, July 3, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	19	--	--
Melosira lirata	76	--	--
Order Pennales			
Achnanthes detha	--	19	57
Asterionella formosa	718	624	795
Synedra radians	--	--	28
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	38	38	28
Ankistrodesmus nannoselene	--	--	28
Chlamydomonas sp. 1	208	95	227
Chlamydomonas sp. 2	57	19	28
Chlamydomonas sp. 3	38	19	--
Chlorella ellipsoidea	284	132	199
Chlorogonium sp.	19	--	--
Eudorina elegans	138	--	85
Gonium sociale	--	--	114
Gonium sp.	--	19	28
Scenedesmus sp. 2	38	--	57
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	76	76	57
Dinobryon pediforme	--	19	28
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	57	--	85
Oscillatoria limnetica	548	--	--
PYRROPHYTA (Dinoflagellates)			
Peridinium sp.	--	19	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	435	246	256
Rhodomonas minuta	19	--	--
Total cells per milliliter	2,768	1,325	2,100
Number of species	16	12	16

Table 19.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, July 25, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	28	--	--
Melosira lirata	--	43	--
Order Pennales			
Asterionella formosa	--	--	244
Fragilaria pinnata	28	--	--
Hannaea arcus	--	14	28
Meridion circulare	--	43	--
Nitzschia paleacea	14	--	--
Synedra rumpens var. *familiaris*	28	--	--
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	383	185	142
Chlamydomonas sp. 2	85	256	256
Chlamydomonas sp. 3	43	--	170
Chlorella ellipsoidea	511	454	852
Eudorina elegans	--	57	85
Gonium sp.	--	--	28
Scenedesmus sp.	--	28	--
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	142	99	28
Lyngbya nana	540	--	--
Oscillatoria limnetica	--	43	568
Phormidium sp.	--	454	--
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	--	14	--
Peridinium sp.	--	14	--
CRYPTOPHYTA (Cryptomonads)			
Chilomonas sp.	--	14	--
Total cells per milliliter	1,802	1,718	2,401
Number of species	10	14	10

Table 20.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, August 15, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	--	99	--
Order Pennales			
Cymbella minuta	28	--	--
Diatoma niemale var. *mesodon*	28	--	--
Navicula schmassmannii	--	--	28
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	2,670	--	511
Chlamydomonas sp. 2	5,936	4,658	4,317
Chlorella ellipsoidea	57	28	199
Scenedesmus sp.	--	--	114
CYANOPHYTA (Blue-green algae)			
Anabaena sp.	--	--	170
Chroococcus limneticus	--	28	28
PYRROPHYTA (Dinoflagellates)			
Peridinium inconspicua	28	--	--
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	28	--	--
Total cells per milliliter	8,775	4,813	5,367
Number of species	7	4	7

Table 21.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, August 30, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	--	--	14
Order Pennales			
Achnanthes detha	28	14	--
Asterionella formosa	--	14	--
Diatoma niemale var. *mesodon*	28	114	--
Eunotia sp.	--	14	--
Fragilaria pinnata	14	--	57
Hannaea arcus	--	14	--
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	71	14	227
Chlamydomonas sp. 2	14	--	--
Chlorella ellipsoidea	170	28	14
Chlorella sp.	--	--	4,984
Gonium sp.	4,524	6,248	809
Scenedesmus sp.	28	28	--
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	57	43	--
Chroococcus varius	--	--	28
Oscillatoria limnetica	--	284	199
CRYPTOPHYTA (Cryptomonads)			
Cryptomonas marsonii	--	--	14
Cryptomonas sp.	--	14	--
Total cells per milliliter	5,934	6,829	6,346
Number of species	9	12	9

Table 22.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, September 13, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Melosira lirata	--	114	--
Order Pennales			
Asterionella formosa	--	--	19
Fragilaria pinnata	--	57	--
Navicula minima	28	--	--
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	284	398	142
Chlamydomonas sp. 3	114	--	341
Gonium sp.	3,692	2,048	2,073
CYANOPHYTA (Blue-green algae)			
Chroococcus sp.	28	170	596
Oscillatoria limnetica	6,333	19,028	19,710
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	28	57	28
Total cells per milliliter	10,507	21,872	22,909
Number of species	7	7	7

Table 23.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, October 11, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
Asterionella formosa	--	--	28
Diatoma hiemale var. *mesodon*	--	57	--
CHLOROPHYTA (Green algae)			
Chlamydomonas sp. 1	312	2,556	426
Chlamydomonas sp. 2	--	--	227
Chlamydomonas sp. 3	1,562	142	312
Scenedesmus serratus	--	--	114
Scenedesmus sp.	--	--	114
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon divergens	--	653	170
CYANOPHYTA (Blue-green algae)			
Aphanothece sp.	--	--	1,079
Chroococcus sp.	142	--	--
Oscillatoria limnetica	13,774	7,952	7,725
CRYPTOPHYTA (Cryptomonads)			
Chroomonas sp.	--	--	256
Total cells per milliliter	15,790	11,360	10,451
Number of species	4	5	10

Table 24.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, December 6, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Pennales			
Asterionella formosa	--	28	--
Diatoma hiemale var. *mesodon*	1,732	1,846	341
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	28	227	28
Chlamydomonas sp. 1	2,102	312	426
Chlamydomonas sp. 2	227	--	57
Chlamydomonas sp. 3	--	824	199
Chlorella ellipsoidea	--	114	170
Chlorogonium sp.	341	--	--
Cosmarium sp.	--	28	--
Gonium sp.	--	--	28
Nephrocytium sp.	--	28	--
Scenedesmus sp.	57	256	--
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon sp.	653	1,335	227
CYANOPHYTA (Blue-green algae)			
Chroococcus sp.	511	28	--
Oscillatoria limnetica	1,278	2,698	795
Synecnococcus sp.	--	28	--
PYRROPHYTA (Dinoflagellates)			
Peridinium sp.	369	738	227
CRYPTOPHYTA (Cryptomonads)			
Cryptomonas marsonii	28	--	--
Total cells per milliliter	7,326	8,490	2,498
Number of species	11	14	10

Table 25.--*Species list and density of phytoplankton taxa collected in 1-liter discrete samples from The Loch, January 22, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) H	M	S
BACILLARIOPHYTA (Diatoms)			
Order Centrales			
Cyclotella stelligera	28	--	--
Order Pennales			
Asterionella formosa	4,090	4,317	1,590
CHLOROPHYTA (Green algae)			
Ankistrodesmus falcatus var. *acicularis*	57	114	28
Chlamydomonas sp. 1	--	28	--
Chlorococcum sp.	256	682	227
Nephrocytium sp.	57	257	85
Scenedesmus sp.	57	57	57
CHRYSOPHYTA (Golden-brown algae)			
Dinobryon cylindricum var. *alpinum*	256	511	227
Dinobryon statospore	28	28	--
CYANOPHYTA (Blue-green algae)			
Chroococcus limneticus	710	4,175	2,589
Synecnococcus elongatus	57	--	--
PYRROPHYTA (Dinoflagellates)			
Peridinium bipes var. *travectum*	28	142	28
Dinoflagellate			
CRYPTOPHYTA (Cryptomonads)			
Cryptomonas erosa	--	57	--
Cryptomonas marsonii	28	--	--
Cryptomonas sp.	28	--	--
Total cells per milliliter	5,680	10,368	4,831
Number of species	13	11	8

Table 26.--*Species list and density of phytoplankton taxa collected in net tows from Sky Pond, May 22 and 29, June 12 and 26, July 10 and 24, and August 14, 1984*

[H, hypolimnion; M, metalimnion; S, surface; --, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984						
	5-22	5-29	6-12	6-26	7-10	7-24	8-14[1]
BACILLARIOPHYTA (Diatoms)							
Order Centrales							
Cyclotella stelligera	--	37	--	--	75	--	68
Melosira lirata	154	263	97	523	205	48	31
Order Pennales							
Achnanthes affinis	3	--	--	--	24	--	--
Achnanthes detha	5	--	--	38	72	--	--
Achnanthes linearis	--	223	--	--	--	--	--
Achnanthes linearis f. curta	--	--	--	8	--	--	--
Achnanthes marginulata	2	--	97	8	8	36	--
Achnanthes sp.	--	--	97	--	8	12	--
Asterionella formosa	37,968	65,272	125,127	47,076	13,768	7,814	2,918
Caloneis bacillum	--	--	--	--	19	--	--
Cymbella minuta	--	--	21	4	8	--	--
Cymbella minuta f. latens	--	--	--	--	24	--	--
Diatoma anceps	--	--	--	--	--	5	--
Eunotia incisa	--	--	--	--	4	--	--
Eunotia pectinalis	--	--	--	--	15	--	--
Fragilaria capucina	--	--	--	4	--	12	12
Fragilaria construens var. venter	--	--	--	26	--	12	--
Fragilaria crotonensis	--	223	--	4	--	--	--
Fragilaria pinnata	8	--	843	37	75	189	6
Frustula rhomboides	--	--	--	4	--	--	--
Meridion circulare	--	--	--	26	--	77	6
Navicula contenta var. biceps	--	--	--	--	--	5	--
Navicula minima	--	--	--	11	8	--	6
Navicula psuedoscutiformis	--	--	--	--	16	--	6
Navicula schmassmannii	--	--	--	4	1	31	--
Navicula subbacillum	--	--	--	--	24	--	--
Navicula sp.	--	--	--	4	--	--	--
Nitzschia frustulum	--	--	--	--	--	--	12
Nitzschia linearis	--	--	--	4	--	6	6
Pinnularia borealis	--	--	10	--	19	--	--
Surirella sp.	--	--	--	--	--	--	6

Table 26.--*Species list and density of phytoplankton taxa collected in net tows from Sky Pond, May 22 and 29, June 12 and 26, July 10 and 24, and August 14, 1984*--Continued

Taxa	Density (cells per milliliter) for indicated days in 1984						
	5-22	5-29	6-12	6-26	7-10	7-24	8-14[1]
BACILLARIOPHYTA (Diatoms)--Continued							
Order Pennales--Continued							
Synedra radians	--	--	--	--	--	157	12
Synedra rumpens var. *familiaris*	--	--	--	--	--	5	9
Synedra sp.	--	--	--	26	--	--	--
CHLOROPHYTA (Green algae)							
Ankistrodesmus falcatus var. *acicularis*	--	112	48	--	--	--	--
Chlamydomonas dinobryon	--	598	--	--	--	--	--
Chlamydomonas sp. 1	--	784	145	680	--	2,762	50
Chlamydomonas sp. 2	--	4,898	24	78	280	2,134	6
Chlamydomonas sp. 3	--	--	72	--	--	314	31
Chlorella ellipsoidea	--	--	--	--	467	879	87
Chlorogonium sp.	--	--	--	52	--	--	--
Closterium sp.	--	--	24	--	--	--	--
Corone sp.	--	--	--	--	--	--	12
Cosmarium sp. 1	19	--	--	--	--	--	--
Cosmarium sp. 2	19	--	--	--	--	--	--
Eudorina elegans	42,350	24,173	9,801	2,275	--	2,605	--
Gloeococcus tetrasporus	3,536	336	483	16,372	243	345	--
Gonium sp.	77	--	--	--	--	188	--
Nephrocytium limneticum	--	150	--	--	--	--	--
Octosporiella coloradensis	346	224	531	--	654	--	--
Pandorina morum	192	--	--	--	--	--	--
Pandorina smithii	4,881	2,391	--	--	--	439	--
Pandorina sp.	2,345	--	--	--	--	--	--
Pleodorina californicum	11,760	2,616	--	418	--	--	--
Scenedesmus sp.	--	150	--	--	--	--	--
Schroederia setigera	--	--	386	--	--	--	--
Zoospores	--	--	772	--	243	126	--
CHRYSOPHYTA (Golden-brown algae)							
Dinobryon divergens	77	189	410	4,551	2,298	220	12

Table 26.--*Species list and density of phytoplankton taxa collected in net tows from Sky Pond, May 22 and 29, June 12 and 26, July 10 and 24, and August 14, 1984*--Continued

Taxa	Density (cells per milliliter) for indicated days in 1984						
	5-22	5-29	6-12	6-26	7-10	7-24	8-14[1]
CYANOPHYTA (Blue-green algae)							
Aphanothece sp.	692	--	--	--	--	--	--
Chroococcus limneticus	--	37	--	--	--	188	--
Dactylococcoposis acicularis	--	24	--	--	--	--	--
Dactylococcopsis fasciculatus	--	24	--	--	--	--	--
PYRROPHYTA (Dinoflagellates)							
Peridinium inconspicua	--	--	--	52	--	--	--
CRYPTOPHYTA (Cryptomonads)							
Chroomonas sp.	--	--	121	--	--	--	19
Cryptomonas marsonii	--	--	--	78	--	--	--
Cryptomonas sp.	--	--	48	--	--	--	--
Rhodomonas minuta	--	--	--	--	19	--	--
Total cells per milliliter	104,434	103,044	139,785	73,828	20,632	28,621	8,607
Number of species	18	19	23	27	26	26	21

[1]Sample not well preserved.

Table 27.--*Species list and density of phytoplankton taxa collected in net tows from Sky Pond, September 11 and October 9, 1984*

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984	
	9-11	10-9
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
Melosira lirata	23	71
Order Pennales		
Achnanthes affinis	1	--
Achnanthes detha	<1	--
Achnanthes levanderi	1	
Achnanthes linearis	1	--
Anomoeoneis serians var. *brachysira*	<1	--
Asterionella formosa	598	875
Caloneis bacillum	--	1
Cymbella minuta f. latens	6	--
Fragilaria crotonensis	2	--
Fragilaria leptostauron var. *dubia*	4	13
Fragilaria pinnata	25	79
Fragilaria virescens	--	7
Navicula elginensis var. *lata*	<1	--
Navicula luzonensis	<1	--
Navicula minima	1	1
Navicula minuscula	--	1
Navicula schmassmanii	<1	--
Nitzschia frustulum	<1	7
Nitzschia linearis	<1	--
Nitzschia microcephala	<1	--
Syndera rumpens var. *familiaris*	15	12
CHLOROPHYTA (Green algae)		
Chlamydomonas sp. 1	18	2,170
Chlamydomonas sp. 2	--	173
Chlamydomonas sp. 3	--	74
Chlorococcum infusionum	375	--
Dictyosphaerium sp.	--	99
Eudorina sp.	94	444
Gloeocystis sp.	--	99
Gonium sociale	23	--
Gonium sp.	463	2,565
Octosporiella coloradensis	--	99
Pandorina morum	70	--
CYANOPHYTA (Blue-green algae)		
Oscillatoria limnetica	75,633	133,283
Total cells per milliliter	77,355	140,048
Number of species	26	19

Table 28.--*Species list and density of phytoplankton taxa collected in net tows from Glass Lake, May 22, 1984*

Taxa	Density (cells per milliliter) for 5-22-84
BACILLARIOPHYTA (Diatoms)	
Order Pennales	
Asterionella formosa	97,704
CHLOROPHYTA (Green algae)	
Ankistrodesmus falcatus var. *acicularis*	143
Eudorina sp.	31,563
Gonium sp.	574
Nephrocytium sp.	430
CHRYSOPHYTA (Golden-brown algae)	
Dinobryon divergens	10,184
CYANOPHYTA (Blue-green algae)	
Aphanothece sp.	47,633
Chroococcus dispersus	143
Total cells per milliliter	188,374
Number of species	8

Table 29.--*Species list and density of phytoplankton taxa collected in net tows from The Loch, May 23, 1983, and June 5, 13, 20, and 27, 1984*

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1983 and 1984				
	1983	1984			
	5-22	6-5	6-13	6-20	6-27
BACILLARIOPHYTA (Diatoms)					
Order Centrales					
Cyclotella stelligera	36	15	30	1,049	--
Melosira lirata	--	--	81	29	454
Order Pennales					
Achnanthes affinis	--	5	--	--	2
Achnanthes austriaca	--	--	--	--	1
Achnanthes clevei	--	--	--	--	2
Achnanthes detha	24	5	3	--	18
Achnanthes linearis	--	21	--	--	1
Achnanthes marginulata	--	26	--	--	1
Asterionella formosa	2,726	20,153	6,880	22,119	6,893
Caloneis sp.	--	--	--	--	17
Cymbella lunata	--	--	--	--	1
Cymbella minuta	--	--	--	--	1
Cymbella minuta var. *silesica*	--	--	--	--	2
Diatoma anceps	--	--	--	--	34
Diatoma hiemale var. *mesodon*	4	15	10	9	--
Eunotia pectinalis	--	--	--	--	1
Fragilaria capucina	8	--	101	--	9
Fragilaria construens var. *venter*	--	--	--	--	8
Fragilaria crotonensis	--	--	--	18	--
Fragilaria pinnata	--	51	--	--	45
Frustula rhomboides	4	--	3	--	--
Hannaea arcus	12	10	6	--	--
Hannaea arcus var. *amphioxys*	--	--	--	--	1
Hantzschia amphioxys	--	--	--	--	1
Meridion circulare	--	10	10	--	17
Navicula arvensis	--	--	--	--	2
Navicula contenta var. *biceps*	4	--	3	--	--
Navicula minima	--	--	--	--	2
Navicula pseudoscutiformis	8	--	3	--	--
Navicula schmassmannii	12	--	--	--	2
Navicula viridula	--	--	--	--	1
Navicula sp.	--	--	--	--	1
Nitzschia frustulum	--	--	10	--	--
Nitzschia paleacea	--	--	--	--	1
Pinnularia borealis	4	--	--	--	1
Rhopalodia gibba	4	--	--	--	--

Table 29.--*Species list and density of phytoplankton taxa collected in net tows from The Loch, May 23, 1983, and June 5, 13, 20, and 27, 1984*--Continued

Taxa	Density (cells per milliliter) for indicated days in 1983 and 1984				
	1983	1984			
	5-22	6-5	6-13	6-20	6-27
BACILLARIOPHYTA (Diatoms)--Continued					
Order Pennales--Continued					
Synedra pmansitica	--	5	--	--	--
Synedra radians	12	--	10	87	50
CHLOROPHYTA (Green algae)					
Ankistodesmus convolutus	--	33	--	--	--
Ankistrodesmus falcatus	--	--	--	--	34
Ankistrodesmus falcatus var. *acicularis*	12	33	--	29	--
Ankistrodesmus nannoselene	24	--	--	--	--
Chlamydomonas sp. 1	--	--	20	50	--
Chlamydomonas sp. 2	24	520	--	175	--
Cosmarium sp.	--	--	--	58	--
Eudorina elegans	--	2,702	787	4,925	--
Gloeococcus tetraspora	18	585	222	--	--
Octosporiella coloradensis	--	--	222	495	--
Pandorina morum	--	--	--	29	--
Scenedesmus abundans	--	--	--	--	67
Scenedesmus serratus	--	--	--	--	67
Scenedesmus sp.	24	195	--	--	--
CHRYSOPHYTA (Golden-brown algae)					
Dinobryon divergens	24	--	293	262	605
CYANOPHYTA (Blue-green algae)					
Anabaena sp.	--	--	--	--	--
Aphanocapsa delicatissima	--	--	--	--	960
Aphanotheca sp.	--	193	--	--	--
Lyngbya nana	--	--	--	--	269
Microcystis sp.	598	--	--	--	--
Oscillatoria limnetica	--	488	--	700	--
Synechococcus linearis	36	--	--	--	--
Synechocystis sp.	60	--	--	--	--
PYRROPHYTA (Dinoflagellates)					
Peridinium inconspicua	72	--	--	--	--
CRYPTOPHYTA (Cryptomonads)					
Rhodomonas sp.	--	5	--	--	--
Total cells per milliliter	3,750	25,070	8,704	30,034	9,606
Number of species	23	20	18	15	36

Table 30.--*Species list and density of phytoplankton taxa collected in net tows from The Loch, July 3, 17, and 25, and August 15, and 30, 1984*

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984				
	7-3	7-17	7-25	8-15	8-30
BACILLARIOPHYTA (Diatoms)					
Order Centrales					
Cyclotella stelligera	--	5	--	5	74
Melosira lirata	169	225	233	193	50
Order Pennales					
Achnanthes affinis	--	2	--	--	--
Achnanthes austriaca	--	--	--	5	--
Achnanthes detha	--	17	6	16	21
Achnanthes lanceolata	--	--	--	11	--
Achnanthes linearis	--	1	2	--	--
Achnanthes marginulata	--	1	2	--	--
Achnanthes minutissima	5	--	--	--	--
Asterionella formosa	1,290	188	174	11	--
Caloneis sp.	--	--	--	5	--
Cymbella minuta	--	5	--	11	--
Cymbella minuta var. *silesica*	--	--	--	5	--
Diatoma anceps	5	16	--	--	--
Diatoma hiemale var. *mesodon*	10	31	23	16	74
Fragilaria construens var. *venter*	--	--	2	--	--
Fragilaria crotonensis	--	--	2	--	--
Fragilaria pinnata	--	5	9	55	74
Fragilaria vaucheriae	--	--	--	16	--
Hannaea arcus	5	21	12	22	21
Hannaea arcus var. *amphioxys*	5	--	--	11	--
Meridion circulare	10	31	233	22	--
Navicula arvensis	--	--	--	5	--
Navicula cryptocephala var. *venta*	--	--	--	5	--
Navicula cuspidata	--	5	--	--	--
Navicula notha	--	--	--	11	--
Navicula pseudoscutiformis	--	2	--	--	--
Navicula pupula	--	2	--	--	--
Navicula radiosa	5	--	--	--	--
Navicula schmassmanni	10	--	--	22	9
Navicula sp.	5	--	--	--	--
Pinnularia abaujensis var. *rostrata*	--	--	--	5	--
Pinnularia borealis	--	--	--	5	--
Stauroneis smithii	--	--	--	5	--

Table 30.--*Species list and density of phytoplankton taxa collected in net tows from The Loch, July 3, 17, and 25, and August 15, and 30, 1984*--Continued

Taxa	Density (cells per milliliter) for indicated days in 1984				
	7-3	7-17	7-25	8-15	8-30
BACILLARIOPHYTA (Diatoms)--Continued					
Order Pennales--Continued					
Synedra radians	10	--	12	11	--
Synedra rumpens var. *familiaris*	--	--	12	3	--
CHLOROPHYTA (Green algae)					
Chlamydomonas sp. 1	--	--	58	44	1,270
Chlamydomonas sp. 2	--	--	12	208	25
Chlorella ellipsoidea	--	--	23	--	--
Cosmarium sp.	--	5	--	--	--
Eudorina elegans	179	--	--	--	--
Gonium sp.	--	--	--	27	100
Pteromonas sp.	--	--	12	27	--
Scenedesmus abundans	--	--	--	22	--
Scenedesmus quadricauda var. *maximum*	--	--	--	22	--
Scenedesmus serratus	--	--	--	22	--
Spirogyra sp.	5	--	--	55	--
Staurastrum sp.	--	5	--	--	--
CHRYSOPHYTA (Golden-brown algae)					
Dinobryon divergens	95	141	--	--	--
Dinobryon pediforme	15	--	--	--	--
CHYANOPHYTA (Blue-green algae)					
Anabaena sp.	120	--	--	175	--
Aphanotheca sp.	--	--	--	--	1,021
Chroococcus limneticus	--	--	12	5	50
Chroococcus varius	--	--	--	--	100
Lyngbya nana	--	--	116	66	--
Lyngbya sp.	--	--	--	55	--
Oscillatoria limnetica	--	--	--	--	349
Oscillatoria sp.	--	--	--	55	--
PYRROPHYTA (Dinoflagellates)					
Peridinium inconspicua	5	--	--	--	--
Peridinium sp.	--	5	56	--	--
CRYPTOPHYTA (Cryptomonads)					
Chilomonas sp.	--	--	12	--	--
Total cells per milliliter	1,948	714	1,023	1,270	3,241
Number of species	18	20	21	37	15

Table 31.--*Species list and density of phytoplankton taxa collected in net tows from The Loch, September 13 and October 11, 1984*

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984	
	9-13	10-11
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
Melosira lirata	368	--
Order Pennales		
Achnanthes detha	15	10
Achnanthes sp.	5	--
Asterionella formosa	90	186
Diatoma hiemale var. *mesodon*	1	10
Fragilaria construens var. *venter*	43	--
Fragilaria pinnata	129	39
Fragilaria virescens	32	--
Meridion circulare	164	--
Navicula minima	20	20
Tabellaria flocculosa	--	10
CHLOROPHYTA (Green algae)		
Chlamydomonas sp. 1	41	20
Chlamydomonas sp. 3	286	29
Closterium sp.	24	--
Elakotothrix viridis	--	20
Gonium sp.	980	--
Sphaerozosma sp.	41	--
CYANOPHYTA (Blue-green algae)		
Anabaena sp.	204	--
Nostoc paludosum	164	--
Oscillatoria limnetica	10,519	15,143
PYRROPHYTA (Dinoflagellates)		
Peridinium inconspicua	--	20
Total cells per milliliter	13,126	15,507
Number of species	18	11

Table 32.--*Species list and density of phytoplankton taxa collected in net tows from Sky Pond, December 4, and The Loch, December 6, 1984*

[--, indicates species not found]

Taxa	Density (cells per milliliter) for indicated days in 1984	
	Sky Pond 12-4	The Loch 12-6
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
Cyclotella stelligera	17	14
Melosira lirata	50	14
Order Pennales		
Anomoeoneis serians var. *brachysira*	--	14
Asterionella formosa	290	8,453
Fragilaria pinnata	17	--
Fragilaria vaucheriae	--	2
Hannaea arcus	--	3
Navicula radiosa	2	--
Navicula viricula var. *aveame*	--	21
Navicula sp.	8	--
Nitzschia dissipata	--	3
Pinnularia borealis	--	2
CHLOROPHYTA (Green algae)		
Ankistodesmus falcatus var. *acicularis*	--	14
Chlamydomonas sp. 1	12	307
Chlamydomonas sp. 2	--	7
Chlamydomonas sp. 3	4	--
Chlamydomonas sp. 4	--	7
Gonium sp.	12	--
Scenedesmus sp.	8	70
CHRYSOPHYTA (Golden-brown algae)		
Dinobryon cylindricum var. *alpinum*	103	4,129
CYANOPHYTA (Blue-green algae)		
Gloeothece sp.	--	42
Oscillatoria limnetica	14,655	586
Oscillatoria sp.	--	112
PYRROPHYTA (Dinoflagellates)		
Peridinium sp.	--	1,381
Total cells per milliliter	15,178	15,181
Number of species	12	19

Table 33.--*Species list and density of phytoplankton taxa collected from Sky Pond, and The Loch, January 22, 1985*

[--, indicates species not found]

Taxa	Density (cells per milliliter) for 1-22-85	
	Sky Pond	The Loch
BACILLARIOPHYTA (Diatoms)		
Order Centrales		
Melosira lirata	--	67
Order Pennales		
Asterionella formosa	3,837	14,351
Fragilaria pinnata	18	--
CHLOROPHYTA (Green algae)		
Ankistrodesmus falcatus var. *acicularis*	50	59
Eudorina elegans	114	--
CHRYSOPHYTA (Golden-brown algae)		
Dinobryon cylindricum var. *alpinum*	5,660	1,353
CYANOPHYTA (Blue-green algae)		
Synechococcus sp.	--	134
PYRROPHYTA (Dinoflagellates)		
Peridinium bipes var. *travectum*	14	849
Total cells per milliliter	9,693	16,813
Number of species	6	6

Table 34.--*Seasonal changes in concentrations of chlorophyll a and phaeopigments, and in fluorescence data for Sky Pond*

[S, surface; M, metalimnion; H, hypolimnion; C, chlorophyll a, in micrograms per liter; P, phaeopigments, in micrograms per liter; F, fluorescense of living phytoplankton, in relative *in vivo* fluorescence units; --, indicates no data]

Sampling date	Characteristic	Depth (meters) S 0.5	1.0	2.0	M 3.0	4.0	5.0	6.0	H 6.5
5-22-84	C	11.0	--	--	--	--	--	--	--
	P	2.5	--	--	--	--	--	--	--
5-29-84	C	6.9	--	--	6.7	--	--	--	9.4
	P	.84	--	--	1.8	--	--	--	2.5
6-12-84	C	6.6	--	--	6.4	--	--	--	7.0
	P	.70	--	--	.36	--	--	--	.62
6-26-84	C	3.3	--	--	3.2	--	--	--	2.6
	P	.07	--	--	.16	--	--	--	.38
	F	6.2	2.3	2.5	2.4	2.3	2.4	2.6	--
7-10-84	C	1.38	--	--	1.76	--	--	--	1.7
	P	.43	--	--	.41	--	--	--	.3
	F	1.84	1.80	1.74	1.99	1.77	1.65	1.87	--
7-24-84	C	2.2	--	--	2.1	--	--	--	2.3
	P	.68	--	--	.65	--	--	--	.67
	F	3.6	3.8	3.5	3.4	3.3	3.3	3.1	2.8
8-14-84	C	4.4	--	--	3.8	--	--	--	4.0
	P	.65	--	--	1.1	--	--	--	1.0
	F	3.1	3.0	2.8	2.9	3.0	2.8	2.8	2.8
9-11-84	C	5.73	--	--	5.8	--	--	--	6.3
	P	.34	--	--	.5	--	--	--	0
	F	1.68	1.84	1.84	1.77	1.77	1.9	1.71	1.77
10-9-84	C	6.15	--	--	5.22	--	--	--	6.6
	P	.81	--	--	--	--	--	--	.5
12-4-84	C	1.9	--	--	--	--	--	--	1.6
	P	1.1	--	--	--	--	--	--	3.7

Table 35.--*Seasonal changes in concentrations of chlorophyll a and phaeopigments, and in fluorescence data for The Loch*

[S, surface; M, metalimnion; H, hypolimnion; C, chlorophyll a, in micrograms per liter; P, phaeopigments, in micrograms per liter; F, fluorescense of living phytoplankton, in relative *in vivo* fluorescence units; --, indicates no data]

Sampling date	Characteristic	Depth (meters) S 0.5	1.0	M 2.0	3.0	H 4.0	H 4.8
5-23-84	C	0.34	--	0.75	--	--	--
	P	.21	--	.19	--	--	--
6-5-84	C	1.30	--	1.76	--	1.04	--
	P	.33	--	.18	--	0	--
6-13-84	C	1.47	--	1.57	--	1.43	--
	P	.28	--	.23	--	.49	--
6-27-85	C	.74	--	.43	--	--	--
	P	.12	--	.14	--	--	--
	F	1.08	1.14	1.20	1.20	1.17	--
7-3-84	C	.29	--	.22	--	.33	--
	P	.14	--	.12	--	.11	--
	F	.76	.79	.76	.79	.76	--
7-17-84	C	.23	--	.25	--	.61	--
	P	--	--	.27	--	.36	--
	F	1.17	1.20	1.36	1.30	1.30	--
7-25-84	C	.53	--	.63	--	.72	--
	P	.39	--	.41	--	.44	--
	F	1.33	1.23	1.14	1.27	1.08	--
8-15-84	C	.63	--	2.03	--	--	2.86
	P	.29	--	.63	--	--	.58
	F	1.33	.6	2.09	2.12	3.1	2.0
8-30-84	C	2.75	--	3.52	--	--	2.89
	P	.19	--	.15	--	--	.20
	F	2.4	2.2	2.6	2.9	2.5	2.5
9-13-84	C	1.74	--	2.02	--	--	1.69
	P	.61	--	.43	--	--	.61
	F	1.74	1.96	1.96	1.96	1.96	1.30
10-11-84	C	.77	--	0.81	--	--	0.58
	P	.16	--	.21	--	--	.22
	F	1.04	1.11	1.17	1.14	1.14	1.08
12-6-84	C	6.1	--	7.7	--	4.45	--
	P	.71	--	1.93	--	2.00	--

Table 36.--*Seasonal changes in concentrations of nutrients and other chemical constituents in Sky Pond*

[S, surface at 0.5 meter; M, metalimnion at 3 meters; H, hypolimnion at 6.5 meters; NO_3, nitrate; NO_2, nitrite; NH_4, ammonia; PO_4, phosphate; P, phosphorous; SiO_2, silica; Fe, iron; Ca, calcium; SO_4, sulfate; µg/L, microgram per liter; µM, micromolar; mg/L, milligrams per liter; --, indicates no data]

Sampling date	Depth (S,M,H)	NO_3 (µg/L)	NO_2 (µg/L)	NH_4 (µg/L)	PO_4 (µM)	Total P (mg/L)	SiO_2 (mg/L)	Fe (µg/L)	Ca (mg/L)	SO_4 (mg/L)
1-9-84	S	532	--	11.5	0.06	--	1.3	13	1.3	1.72
	M	532	--	7.7	.06	--	1.6	16	1.4	1.76
	H	266	--	20	.06	--	.58	23	1.3	1.86
2-28-84	S	930	--	288	.29	--	1.6	21	1.8	2.09
	M	433	--	282	.23	--	1.0	16	1.4	1.67
	H	266	--	300	.29	--	1.3	280	1.6	1.49
5-8-84	S	221	--	27	.03	--	.7	--	1.5	1.73
	M	--	--	5	.09	--	.3	25	1.6	1.77
	H	221	--	75	.16	--	1.8	390	1.8	1.68
5-15-84	S	886	--	101	.06	--	.6	35	1.5	.89
	M	89	--	28	.03	--	.3	20	1.4	1.84
	H	44	--	14	.23	--	.1	71	1.5	1.73
5-22-84	S	1,285	--	69	.13	--	.76	32	1.4	1.89
	M	399	--	41	.13	--	.4	38	1.6	1.98
	H	177	--	51	.19	--	.37	58	1.6	1.98
5-29-84	S	1,550	--	68	.26	--	1.0	38	1.5	1.88
	M	1,420	--	83	.09	--	1.0	35	1.5	1.82
	H	1,420	--	61	.13	--	--	39	1.5	1.85
6-12-84	S	--	--	--	.03	0.01	--	--	--	--
	M	1,950	--	51	.03	.01	.8	19	1.6	1.95
	H	1,900	--	57	.03	.01	--	13	--	1.95
6-26-84	S	1,595	--	23	.16	.01	1.0	14	1.2	1.53
	M	1,595	--	27	.13	.01	1.0	17	1.3	1.5
	H	1,640	--	29	.19	--	1.0	26	1.3	1.56
7-10-84	S	--	--	--	1.26	.01	--	--	--	--
	M	--	6.6	10	.94	.01	--	--	--	--
	H	--	6.6	11	.97	.01	--	--	--	--
7-24-84	S	709	10	22	.68	.01	1.1	26	.8	.84
	M	757	10	40	.62	.01	--	--	--	--
	H	886	6.6	27	.62	.02	1.1	29	.8	.88
8-14-84	S	709	12	--	.06	.01	--	11	--	.92
	M	660	10	28	.13	.01	--	--	--	--
	H	753	6.6	10	.06	.01	1.1	6	.08	.95
9-11-84	S	709	23	19	6.0	.01	1.4	25	1.0	--
	M	731	23	22	.19	.01	--	--	--	--
	H	753	23	22	.19	.01	1.4	13	1.0	--
10-9-84	S	930	--	6	.03	.01	--	6	--	1.4
	M	886	10	9	.06	.01	--	--	--	--
	H	886	--	6	.06	.01		12	--	1.4
12-4-84	S	1,950	--	24	.06	2		12	--	2.4
	M	--	--	--	--	--	--	--	--	2.4
	H	930	--	41	.06	.01	--	35	--	1.7

Table 37.--*Seasonal changes in concentrations of nutrients and other chemical constituents in The Loch*

[S, surface at 0.5 meter; M, metalimnion at 2 meters; H, hypolimnion at 4 meters; NO_3, nitrate; NO_2, nitrite; NH_4, ammonia; PO_4, phosphate; P, phosphorous; SiO_2, silica; Fe, iron; Ca, calcium; SO_4, sulfate; µg/L, microgram per liter; µ*M*, micromolar; mg/L, milligrams per liter; --, indicates no data]

Sampling date	Depth (S,M,H)	NO_3 (µg/L)	NO_2 (µg/L)	NH_4 (µg/L)	PO_4 (µ*M*)	Total P (mg/L)	SiO_2 (mg/L)	Fe (µg/L)	Ca (mg/L)	SO_4 (mg/L)
12-27-83	S	1,373	--	--	--		3.2	82	2.1	2.41
	M	532	--	--		--	2.1	110	2.4	1.98
	H	399	--	--	--	--	2.2	130	2.0	1.96
3-06-84	S	399	--	26	--	--	2.6	91	2.1	2.18
	M	443	--	27	0.16	--	2.6	96	2.1	2.23
	H	88	--	27	--	--	2.1	100	2.2	2.35
4-17-84	S	975	--	35	.10	--	3.0	120	2.1	2.4
	M	797	--	41	.19	--	1.9	100	2.1	2.35
	H	133	--	9	--	--	1.9	140	2.3	2.22
5-07-84	S	1,063	--	60	.03	--	3.9	240	2.4	2.27
	M	310	--	65	--	--	2.3	180	2.3	2.28
	H	177	--	72	.03	--	2.7	220	2.4	2.12
5-16-84	S	1,640	--	70	.03	--	2.4	99	1.6	1.97
	M	975	--	80	.03	--	2.4	100	1.7	2.19
	H	310	--	72	.03	--	2.3	400	2.4	2.18
5-23-84	S	1,420	--	61	.13	--	2.0	65	1.4	1.81
	M	1,420	--	61	.13	--	2.0	79	1.4	1.96
	H	1,063	--	58	.03	--	2.0	200	1.9	2.09
6-05-84	S	1,370	--	47	.03	0.03	1.7	31	1.4	1.6
	M	1,470	--	42	.03	.02	1.7	37	1.3	1.59
	H	1,420	--	70	.03	.02	1.7	33	1.4	1.62
6-13-84	S	1,595	--	45	.03	.01	2.0	36	1.5	1.72
	M	1,640	--	46	.03	.01	2.0	36	1.6	1.73
	H	1,595	--	44	.03	.01	2.0	37	1.5	1.73
6-20-84	S	1,329	--	40	.16	--	1.6	18	1.1	1.42
	M	1,329	--	42	.16	--	1.7	30	1.3	1.43
	H	1,373	--	33	.19	--	1.7	30	1.3	1.43
6-27-84	S	1,285	--	51	.39	--	1.5	21	1.2	1.35
	M	1,240	--	37	.16	--	1.5	20	1.2	1.31
	H	--	--	--	.19	--	--	--	--	--
7-03-84	S	--	--	43	.19	.01	--	--	--	--
	M	--	--		--	--	--	--	--	--
	H	--	--	41	--	.02	--	--	--	--
7-17-84	S	--	10	19	--	.01	--	--	--	--
	M	--	--	--	--	.01	--	--	--	--
	H	--	6.6	9	.64	.01	--	--	--	--
7-25-84	S	930	6.6	39	.68	.01	1.5	20	1.0	1.14
	M	--	3.3	32	.61	.02	--	--	--	--
	H	930	6.6	36	.64	.01	1.5	21	1.0	1.08

Table 37.--*Seasonal changes in concentrations of nutrients and other chemical constituents in The Loch*--Continued

Sampling date	Depth (S,M,H)	NO_3 (µg/L)	NO_2 (µg/L)	NH_4 (µg/L)	PO_4 (µM)	Total P (mg/L)	SiO_2 (mg/L)	Fe (µg/L)	Ca (mg/L)	SO_4 (mg/L)
8-06-84	S	44	--	10	0.07	--	--	--	0.02?	0.01?
	M	--	--	--	--	--	--	--	--	--
	H	--	--	--	--	--	--	--	--	--
8-15-84	S	665	10	13	.07	.01	1.5	26	1.0	1.14
	M	691	6.6	4	.19	.01	--	--	--	--
	H	--	--	--	.23	.01	--	--	--	--
8-30-84	S	--	--	--	--	--	--	--	--	--
	M	483	6.6	4	.10	.01	--	--	--	--
	H	496	6.6	10	.07	.01	--	--	--	--
9-13-84	S	886	26	22	.19	.01	1.9	21	1.2	1.4
	M	837	23	27	.19	.01	--	--	--	--
	H	890	23	20	.19	.01	1.8	3	1.1	1.4
10-11-84	S	975	--	7	.07	.01	--	--	--	--
	M	1,020	--	10	.07	.01	--	--	--	--
	H	1,060	--	7	.07	.01	--	--	--	--
12-6-84	S	1,150	--	6	.07	2.0	--	--	--	--
	M	841	--	6	.07	--	--	--	--	--
	H	709	--	6	.07	.01	--	--	--	--

Table 38.--*Seasonal changes in concentrations of dissolved organic carbon in surface waters in Loch Vale*

[S, surface; M, metalimnion; H, hypolimnion; --, indicates no data]

Sampling date	Concentration of dissolved organic carbon (milligrams carbon per liter)										
	Sky Pond					The Loch					Loch Creek
	Inlet	Mid-lake station Depth (meters)			Outlet	Inlet	Mid-lake station Depth (meters)			Outlet	
		S 0.5	M 3	H 6			S 0.5	M 2	H 4		
7-3-84	--	--	--	--	--	0.7	0.9	0.8	0.7	0.8	3.6
7-10-84	--	0.6	0.4	0.4	0.4	--	--	--	--	--	--
7-17-84	--	--	--	--	--	.8	1.0	.9	.8	.9	--
7-24-84	--	.5	.5	.5	.5	--	--	--	--	--	--
7-25-84	--	--	--	--	--	.7	.9	.8	.9	.9	2.7
8-14-84	0.2	.3	.4	.4	.4	--	--	--	--	--	--
8-15-84	--	--	--	--	--	.4	.6	.6	.6	.6	2.7
9-11-84	.3	.4	.4	.4	.4	--	--	--	--	--	--
9-13-84	--	--	--	--	--	.6	.8	.8	--	.7	--
10-11-84	--	--	--	--	--	1.3	1.8	2.0	1.8	2.2	--

Table 39.--*Seasonal changes in concentrations of suspended organic carbon in surface waters in Loch Vale*

[S, surface; M, metalimnion; H, hypolimnion; --, indicates no data]

Sampling date	Concentration of suspended organic carbon (milligrams carbon per liter)										
	Sky Pond					The Loch					
	Inlet	Mid-lake station Depth (meters)			Outlet	Inlet	Mid-lake station Depth (meters)			Outlet	Loch Creek
		S 0.5	M 3	H 6			S 0.5	M 2	H 4		
6-5-84	--	--	--	--	--	0.3	0.5	--	1.0	0.2	--
6-12-84	--	0.3	--	--	--	--	--	--	--	--	--
6-20-84	--	--	--	--	--	.1	.2	0.2	.5	.2	--
6-26-84	--	.3	0.4	0.5	0.3	--	--	--	--	--	--
6-27-84	--	--	--	--	--	.2	.1	.2	.2	.2	0.1
7-3-84	--	--	--	--	--	.2	.1	.2	.2	.1	.2
7-10-84	--	.3	.2	.2	.2	--	--	--	--	--	--
7-17-84	--	--	--	--	--	.2	.2	.2	.1	.1	--
7-24-84	--	.3	--	.4	.4	--	--	--	--	--	--
7-25-84	--	--	--	--	--	.2	.3	.2	.2	.2	.1
8-14-84	0.1	.4	.4	.4	--	--	--	--	--	--	--
8-15-84	--	--	--	--	--	.2	.1	.3	.3	.1	.2
8-30-84	--	--	--	--	--	.2	--	--	.2	--	--
9-11-84	--	.5	.5	.5	.3	--	--	--	--	--	--
9-13-84	--	--	--	--	--	.2	.3	.3	.3	.3	--
10-9-84	--	.7	.7	.7	.7	--	--	--	--	--	--
10-11-84	--	--	--	--	--	--	.2	.1	.1	.1	--

Table 40.--*Seasonal changes in pH, temperature, and light intensity in Sky Pond*

[S, surface; M, metalimnion; H, hypolimnion; T, temperature, in degrees celsius; LI, light intensity, in lux; --, indicates no data]

Sampling date	Characteristic	Depth (meters)													
		S						M							H
		0	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5
5-29-84	pH	6.53	--	--	--	--	--	6.67	--	--	--	--	--	6.70	--
	T	2.0	--	--	--	--	--	4.0	--	4.0	--	4.0	--	4.0	--
	LI	--	--	--	--	--	--	--	--	--	--	--	--	--	--
6-12-84	pH	6.59	--	--	--	--	--	--	6.5	--	--	--	--	--	6.59
	T	2.8	--	2.8	--	2.8	--	2.8	--	2.8	--	2.8	--	2.8	2.8
	LI	15,000	11,000	6,500	3,100	2,400	2,000	1,900	1,800	1,400	1,200	1,200	900	600	550
6-26-84	pH	6.70	--	--	--	--	--	--	6.69	--	--	--	--	--	6.80
	T	5.8	--	5.8	--	5.6	--	5.6	--	5.6	--	5.6	--	5.5	5.5
	LI	8,000	--	4,200	--	2,700	--	2,300	--	1,500	--	1,200	--	1,800	1,500
7-10-84	pH	6.4	--	--	--	--	--	6.44	--	--	--	--	--	6.45	--
	T	6.3	--	6.2	--	6.2	--	6.2	--	6.2	--	6.2	--	6.2	--
	LI	2,900	--	2,100	--	1,900	--	1,600	--	1,200	--	730	--	550	--
7-24-84	pH	6.61	--	--	--	--	--	6.38	--	--	--	--	--	--	6.54
	T	6.8	--	6.0	--	5.0	--	5.0	--	5.0	--	5.0	--	5.0	5.0
	LI	16,000	--	8,400	--	7,300	--	4,100	--	2,800	--	1,700	--	1,000	850
8-14-84	pH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	T	7.2	--	7.0	--	7.0	--	6.8	--	6.5	--	6.2	--	6.2	6.1
	LI	16,000	--	12,000	--	8,700	--	4,700	--	4,000	--	2,900	--	2,000	1,600
9-11-84	pH	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	T	5.5	--	5.3	--	5.2	--	5.2	--	5.1	--	5.1	--	5.0	5.0
	LI	3,500	--	2,600	--	1,700	--	1,300	--	840	--	580	--	420	360
10-9-84	pH	7.24	--	--	--	--	--	7.23	--	--	--	--	--	7.27	--
	T	2.0	--	2.0	--	2.10	--	2.0	--	2.0	--	2.0	--	2.0	2.0
	LI	2,600	--	1,600	--	1,100	--	760	--	480	--	340	--	240	220
12-4-84	pH	5.83	--	--	--	--	--	--	--	--	--	--	--	--	5.82
	T	1.0	--	--	--	--	--	--	--	--	--	--	--	--	4.0
	LI	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1-22-85	pH	6.40	--	--	--	--	--	6.41	--	--	--	--	--	6.35	--
	T	1.0	--	--	--	--	--	1.0	--	--	--	--	--	4.0	--
	LI	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table 41.--*Seasonal changes in pH, temperature, and light intensity in The Loch*

[S, surface; M, metalimnion; H, hypolimnion; T, temperature, in degrees celsius; LI, light intensity, in lux; --, indicates no data]

Sampling date	Characteristic	Depth (meters) S 0	0.5	1.0	1.5	M 2.0	2.5	3.0	3.5	4.0	H[1] 4.2-4.8	
5-23-84	pH	6.0	--	--	--	5.97	--	--	--	--	6.10	
	T	3.5	--	4.0	--	4.0	--	4.0	--	4.0	4.0	
	LI	--	--	--	--	--	--	--	--	--	--	
6-5-84	pH	6.35	--	--	--	6.37	--	--	--	--	6.38	
	T	4.0	--	4.0	--	4.0	--	4.0	--	4.0	4.0	
	LI	--	--	--	--	--	--	--	--	--	--	
6-13-84	pH	6.3	--	--	--	--	6.33	--	--	--	6.34	
	T	6.8	--	6.3	--	4.6	--	4.3	--	4.3	4.3	
	LI	13,000	9,800	7,500	5,200	4,200	4,000	3,500	3,000	2,300	1,700	
6-20-84	pH	6.29	--	--	--	6.30	--	--	--	--	6.28	
	T	6.0	--	6.0	--	6.0	--	6.0	--	6.0	6.0	
	LI	--	--	--	--	--	--	--	--	--	--	
6-27-86	pH	6.63	--	--	--	6.59	--	--	--	--	6.57	
	T	6.0	--	6.0	--	6.0	--	6.0	--	6.0	--	
	LI	14,000	12,000	9,500	8,500	6,500	5,500	4,500	3,500	3,000	--	
7-3-84	pH	6.51	--	--	--	6.43	--	--	--	6.47	--	
	T	6.8	--	6.4	--	6.4	--	6.3	--	6.2	--	
	LI	15,000	--	10,000	--	7,000	--	5,400	--	4,000	--	
7-17-74	pH	6.33	--	--	--	--	6.47	--	--	--	6.38	
	T	8.8	--	7.5	--	7.4	--	7.3	--	7.2	7.2	
	LI	18,000	--	13,000	--	10,000	--	6,500	--	6,000	5,500	(4.5m)
7-25-84	pH	6.47	--	--	--	6.48	--	--	--	--	6.49	
	T	7.2	--	6.9	--	6.9	--	6.8	--	6.7	6.6	
	LI	--	--	--	--	--	--	--	--	--	--	
8-15-84	pH	6.78	--	--	--	--	--	--	--	6.59	--	
	T	11	--	9.0	--	8.8	--	8.5	--	8.2	8.2	
	LI	5,000	--	2,800	--	2,100	--	1,500	--	11,000	1,000	(4.8m)
8-30-84	pH	6.53	--	--	--	6.58	--	--	--	--	6.43	
	T	8.9	--	8.7	--	8.5	--	8.5	--	8.5	8.5	
	LI	15,000	--	12,000	--	8,000	--	5,000	--	3,700	3,200	(4.5m)
9-13-84	pH	--	--	--	--	--	--	--	--	--	--	
	T	7.0	--	6.5	--	6.2	--	6.2	--	6.0	6.0	
	LI	1,500	--	1,100	--	820	--	600	--	450	300	(4.5m)
10-11-84	pH	6.81	--	--	--	6.81	--	--	--	6.84	--	
	T	3.0	--	3.0	--	3.0	--	3.0	--	3.0	3.0	
	LI	8,500	--	6,500	--	3,500	--	2,500	--	1,400	900	(4.5m)
12-6-84	pH	6.2	--	--	--	6.2	--	--	--	6.38	--	
	T	1	--	--	--	--	--	--	--	--	--	
	LI	900	--	130	--	62	--	32	--	15	13	(4.5m)
1-22-85	pH	6.52	--	--	--	6.44	--	--	--	6.36	--	
	T	.5	--	1.0	--	3.0	--	3.9	--	4.0	4.0	
	LI	--	--	--	--	--	--	--	--	--	--	

[1]Actual depth of samples and temperature and light measurements indicated in parenthesis.

Table 42.--*Seasonal extinction coefficient, Secchi depth, and color in Sky Pond and The Loch*

[E, extinction coefficient, Pt, platinum units; m, meters; --, indicates no data]

Sampling date	Sky Pond			The Loch		
	E	Color[1] (Pt)	Secchi depth (m)	E	Color[1] (Pt)	Secchi depth (m)
5-22-84	--	7	--	--	--	--
5-23-84	--	--	--	--	11.3	--
5-29-84	--	6.7	--	--	--	--
6-5-84	--	--	--	--	9	4.2
6-12-84	0.47	4.0	2.8	--	--	--
6-13-84	--	--	--	0.43	9	4.6 - bottom
6-20-84	--	--	--	--	7.3	4.3 - bottom
6-26-84	.36	6.3	4.3	--	--	--
6-27-84	--	--	--	.38	8	4.3 - bottom
7-03-84	--	--	--	.33	--	4.8 - bottom
7-10-84	.27	--	5.0	--	--	--
7-17-84	--	--	--	.27	--	4.8 - bottom
7-24-84	.45	2.0	2.1	--	--	--
7-24-85	--	--	--	--	3.5	4.9 - bottom
8-6-84	--	--	--	--	1.0	--
8-14-84	.35	1.0	4.5	--	--	--
8-15-84	--	--	--	.33	4	4.8 - bottom
8-30-84	--	--	--	.36	--	4.8 - bottom
9-11-84	.36	5.0	3.7	--	--	--
9-13-84	--	--	--	.34	5	4.7 - bottom
10-9-84	.38	--	2.8	--	--	--
10-11-84	--	--	--	.493	--	4.5 - bottom
12-4-84	--	--	--	--	--	--
12-6-84	--	--	--	.88	--	--
1-22-85	--	--	--	--	--	--

[1]Average color values for surface, metalimnion and hypolimnion.

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